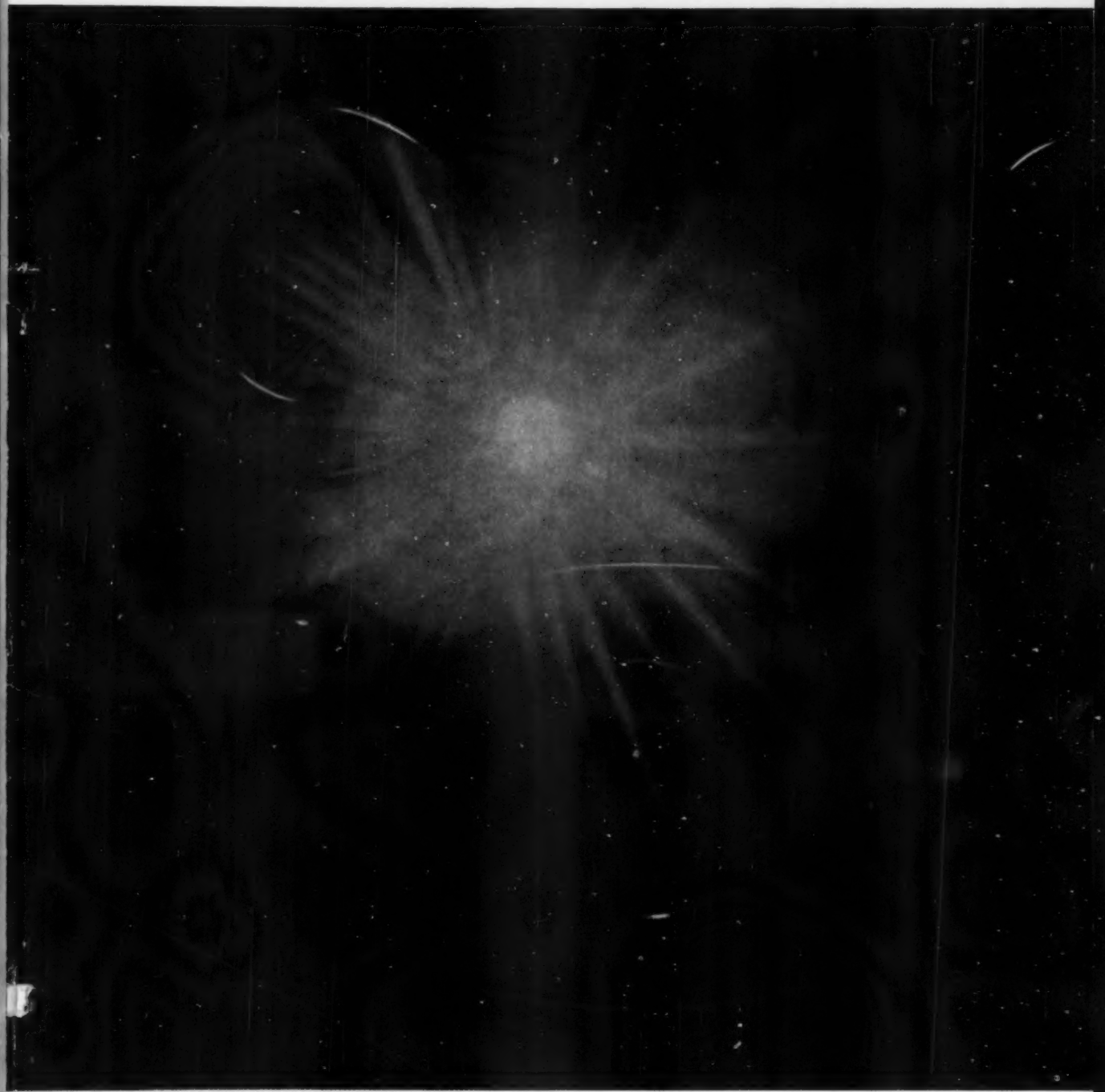
MODERN PLASTICS



DESIGNED AND PHOTOGRAPHED FOR MODERN PLASTICS BY RUDY MULLER

THE NEW LOOK IN SIGNS *p. 90*

Is ABS headed for a boom? *p. 82*

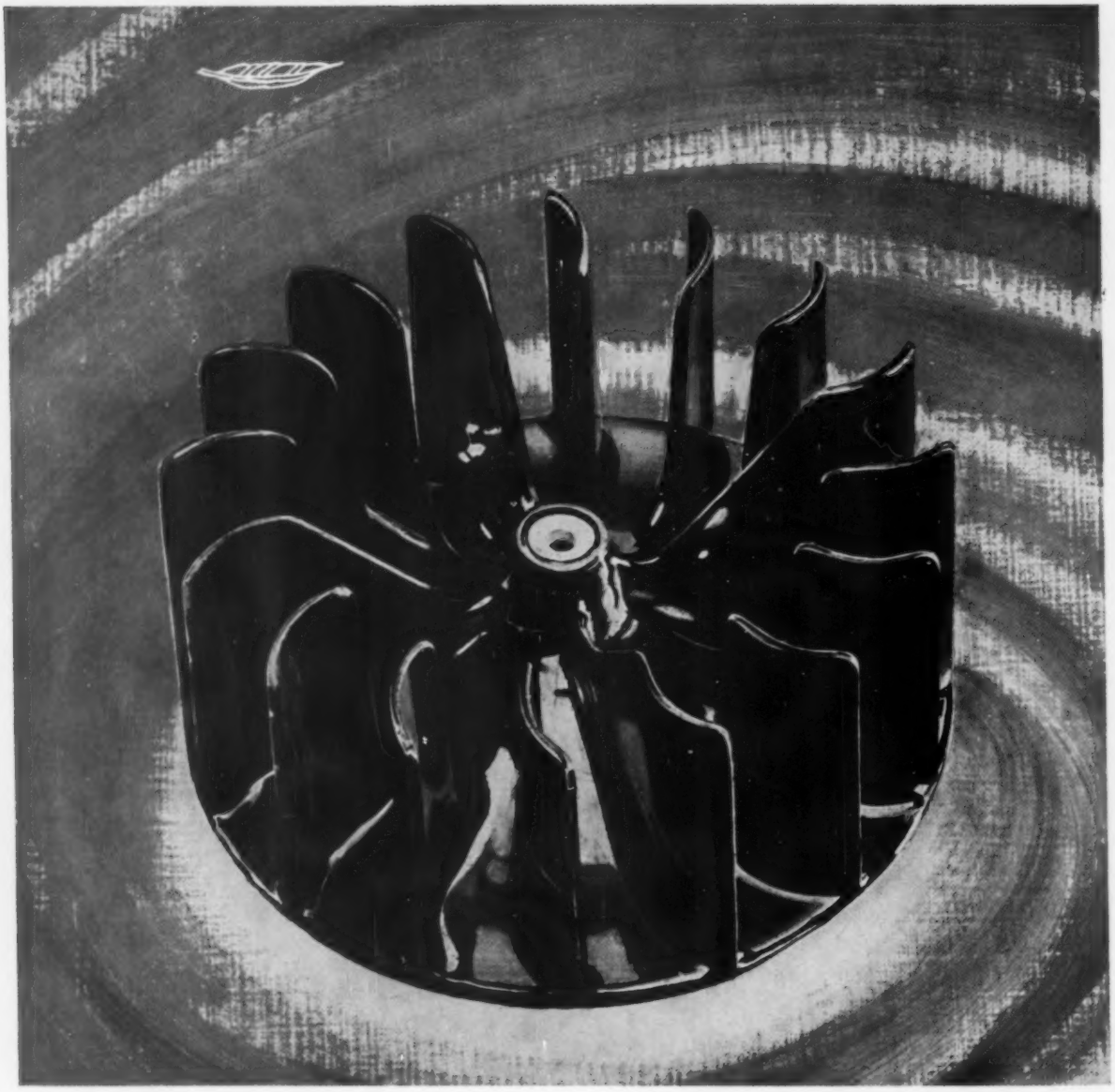
Look what blending chlorinated PE with PVC can do *p. 94*

Urethane foam brings back the gas refrigerator *p. 96*

How to choose embedment equipment *p. 105*

APRIL 1961

One of a series directed to IDEA-MEN



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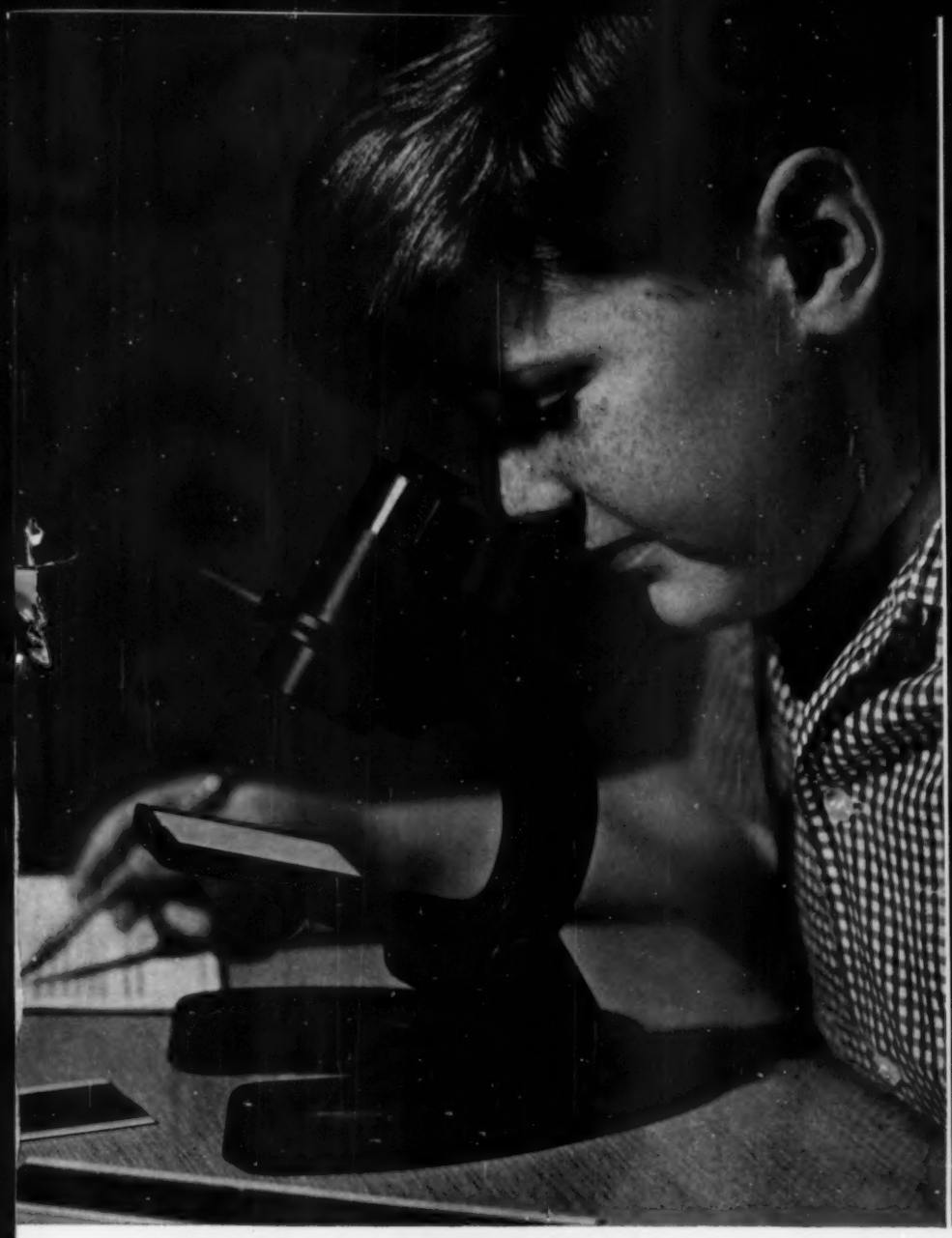

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MODERN PLASTICS*

Volume 38, Number 8 April 1961

THE PLASTISCOPE

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What's the outlook for acetals? (p. 41); More integration in vinyl chloride (p. 43); Polystyrene tumblers by the millions (p. 45); New thermoplastic based on itaconic acid (p. 200); Distributors' group seeks members (p. 200); Expansion (p. 219).

EDITORIAL

Processing research needed 81

The chemical industry has budgeted millions for research and development in 1961, much of it for plastics. Now it is up to the processor to follow the lead of the materials makers in order to reap full advantage from materials development.

GENERAL

Where is ABS headed? 82

Suppliers foresee substantial growth in the decade ahead, with one producer forecasting a half-billion-lb. volume by 1970. Where is it all going to go? And why? Here is an analysis of the markets which the material is expected to penetrate, what poundages may be used in each of them, what properties make it a candidate for a host of new applications. Also analyzed is the present and prospective price structure, and how it is related to the growth of the material.

Polycarbonate replaces metal 87

When a manufacturer of air circulators decided to upgrade his products, he found that molded polycarbonate air diffusers gave him all the necessary properties he previously obtained with metal parts, plus lighter weight, integral color, and greater design flexibility—all without increase in cost.

New market—door hardware 88

Molded and extruded parts have started to show up in a field that until recently was completely dominated by metal. Three case studies, involving lock-sets, hinges, and knobs and spindles, highlight this new trend. Nylon-6/6, nylon-6, ABS, and melamine are the materials used. The design advantages they bring and the economies they permit are spelled out in detail.

The new look in signs 90

Five years ago plastics accounted for 10% of the sign market. Today they may have more than 50 percent. And by 1965 they are expected to reach the 75% level. Why this spectacular growth? Five factors are closely examined, and typical cases are cited pointing up the exciting design potential obtainable with plastics in signs.

Cure cover for concrete 93

Road builders in 23 states find they can do a better job—and in less time—with polyethylene film. Here is how the film is used, what gages are most popular, what are the manpower requirements.

New polymer blend upgrades PVC . . 94

By combining chlorinated polyethylene with rigid PVC, European resin maker developed a material with significantly better low-temperature impact strength and better processability than straight rigid PVC. Price and processing details are given.

Urethane foam brings back the gas refrigerator 96

Discontinued in 1956, the gas refrigerator is now back on the market thanks to thin-wall foam insulation that brings cabinet size and storage capacity in line with comparable electric refrigerators. Here is the story of why the decision was made, and details on how the company incorporated the foaming operation into its over-all mass production line.

Nylon fuel regulator 99

In another automotive first, the economy of the injection molding process combined with nylon's resistance to high engine temperatures have won for nylon a new and significant under-the-hood automotive application.

And now—pontoons of reinforced plastics 100

After their resounding success in the boat field, it was only a matter of time until glass-polyesters turned up in floating docks. Now two manufacturers have announced pontoons that supersede inconvenient and dangerous pile-supported walkways in providing access to boats. One company uses spray-up, the other preform molding. Both end up with products expected to spearhead a strong movement of reinforced plastics into the dock market.

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ENGINEERING

Equipment for embedment **105**
Encapsulation of electronic equipment has today reached the point where it is changing over from a manual art to a production process that is at least semi-automatic and that may soon become fully automated. The steps involved in embedment are mixing the compound; storing, transferring, and evacuating; proportioning and dispensing the mixture and catalysts; and curing the catalyzed compound. Here are the guide posts that should govern the selection of the various types of equipment best suited for these operations.
By C. A. Harper

How to determine resin cure **117**
A new test method provides a quick and easy technique for determining the degree of cure in phenolic resin-impregnated materials. The procedure is reproducible with a high degree of accuracy and can be completed in a short time so that it can be employed in quality-control operations.
By John C. H. Chang

TECHNICAL

Adsorption of polymers on glass and other substrates—Part I **123**
The nature of the attractive forces between resins and glass fibers and finishes should be known in order to make rational selections of compounds for reinforced plastics. One way of studying these forces is through the exploration of adsorption of polymers. Part I covers rate of adsorption, nature of adsorbent surface, effect of solvent, and molecular weight of polymer. Part II, to be published in a forthcoming issue, will deal with temperature, adsorption-desorption reversibility, and configuration of the adsorbate molecule; and the applicability of several equations to this problem.
By R. R. Stromberg and G. M. Kline

Epoxidized polyolefin resins **135**
Representative cure systems for a spectrum of mechanical and electrical properties for a new group of epoxy resins with interesting characteristics, and how they find application in some special types of reinforced plastics.
By C. W. Johnston and F. P. Greenspan

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Our fabulous pre-show May issue is going to be devoted to the "Wide World of Plastics," with on-the-spot reports from over a dozen countries . . . Statistics of international trade and plastics production . . . alphabetical and classified show guides for the U. S. and European exhibitions . . . and a review of the latest plastics developments in communications, furniture, buildings, appliances, boats, automobiles, lighting, etc. . . . May engineering lead—Guide to polyethylene film corona treaters . . . Technical lead—plastics as rocket fuel binders . . . Also in the works: the largest RP boat . . . polypropylene monofilament . . . which processing is best for large PE parts . . . plastics in science toy kits . . . special color effects . . . ways of processing urethane foam . . . selecting sheet for thermoforming.

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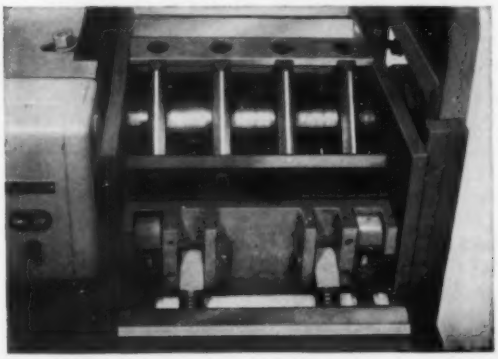

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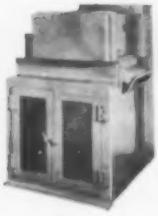

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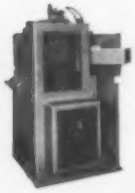

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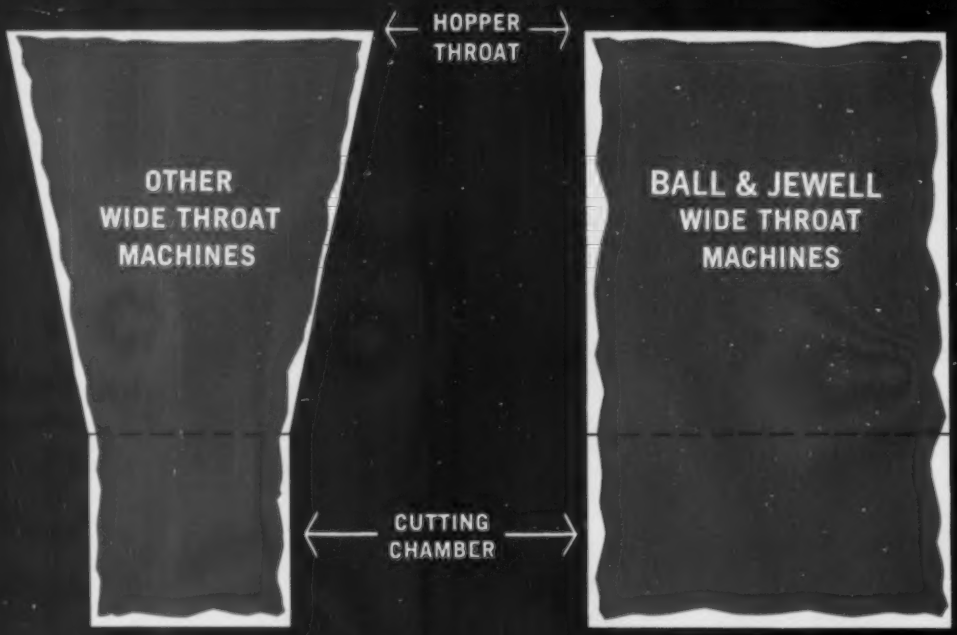

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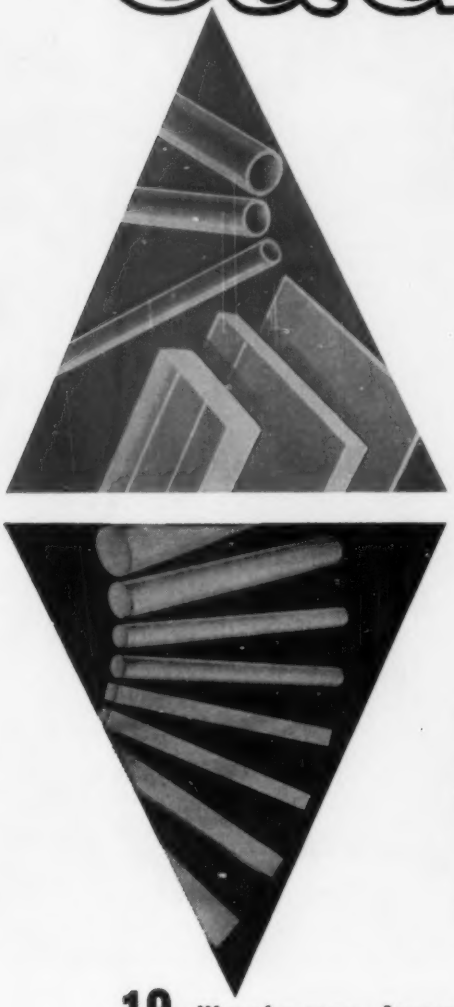

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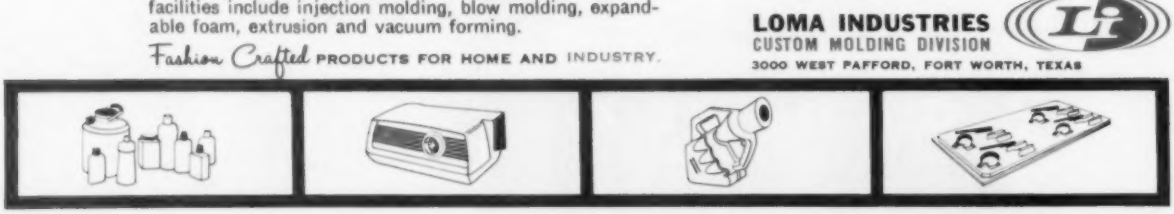

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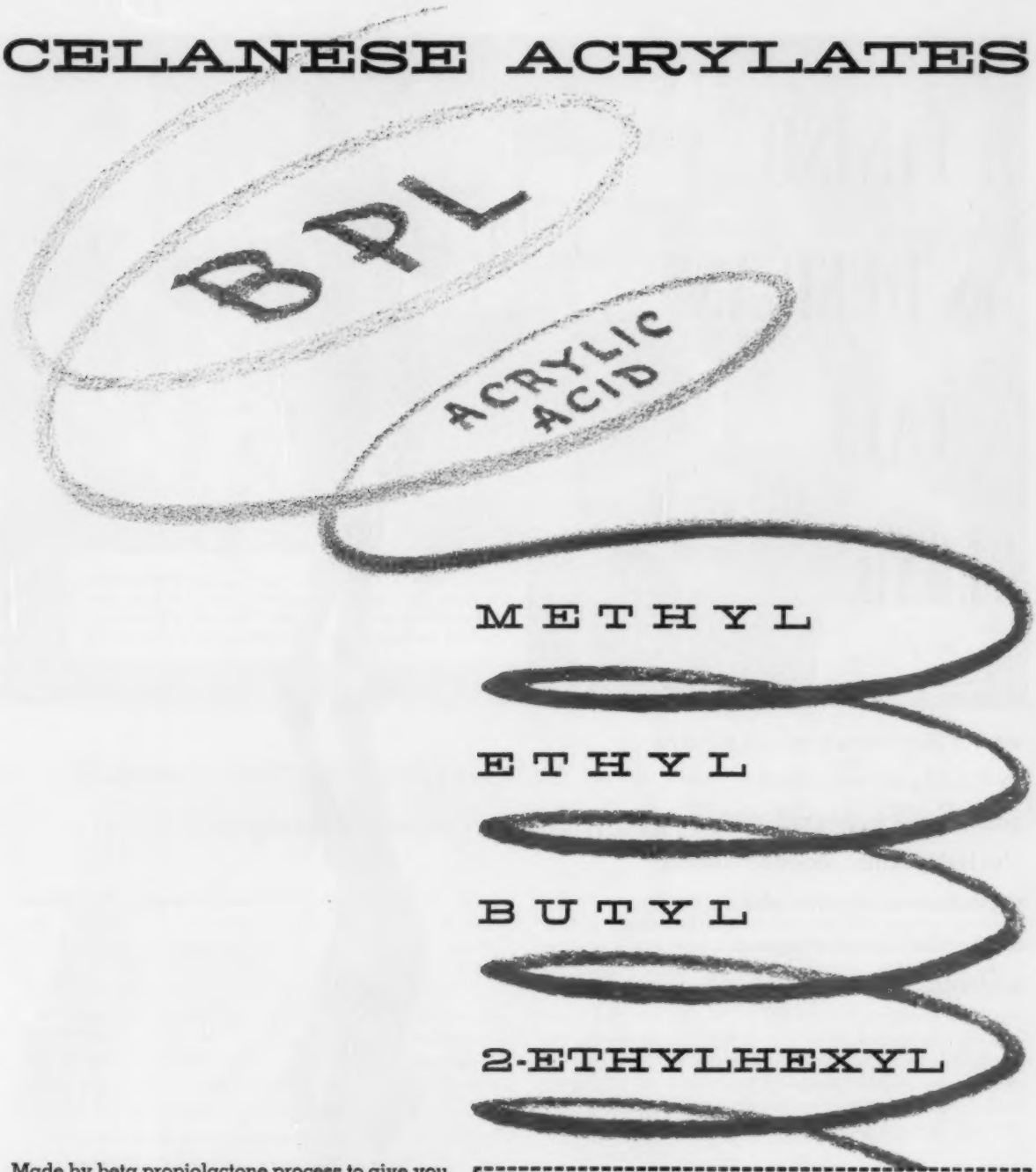

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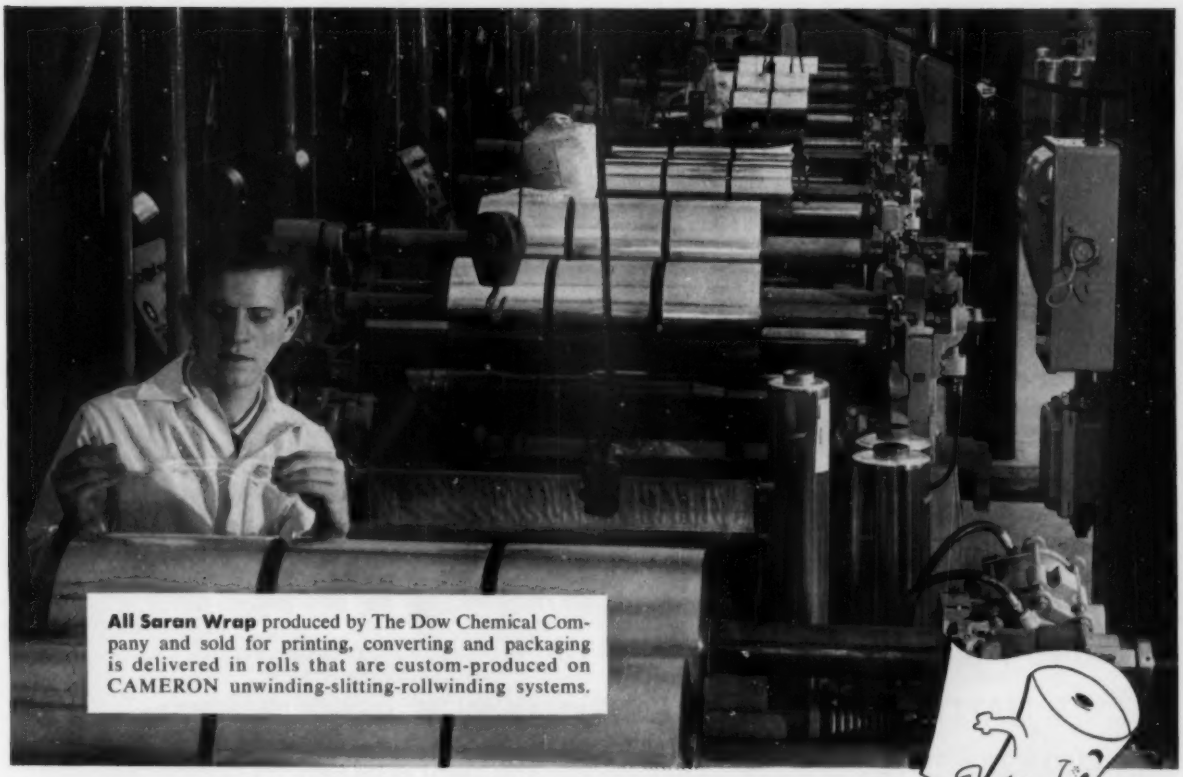

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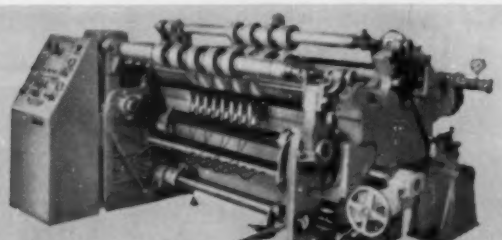

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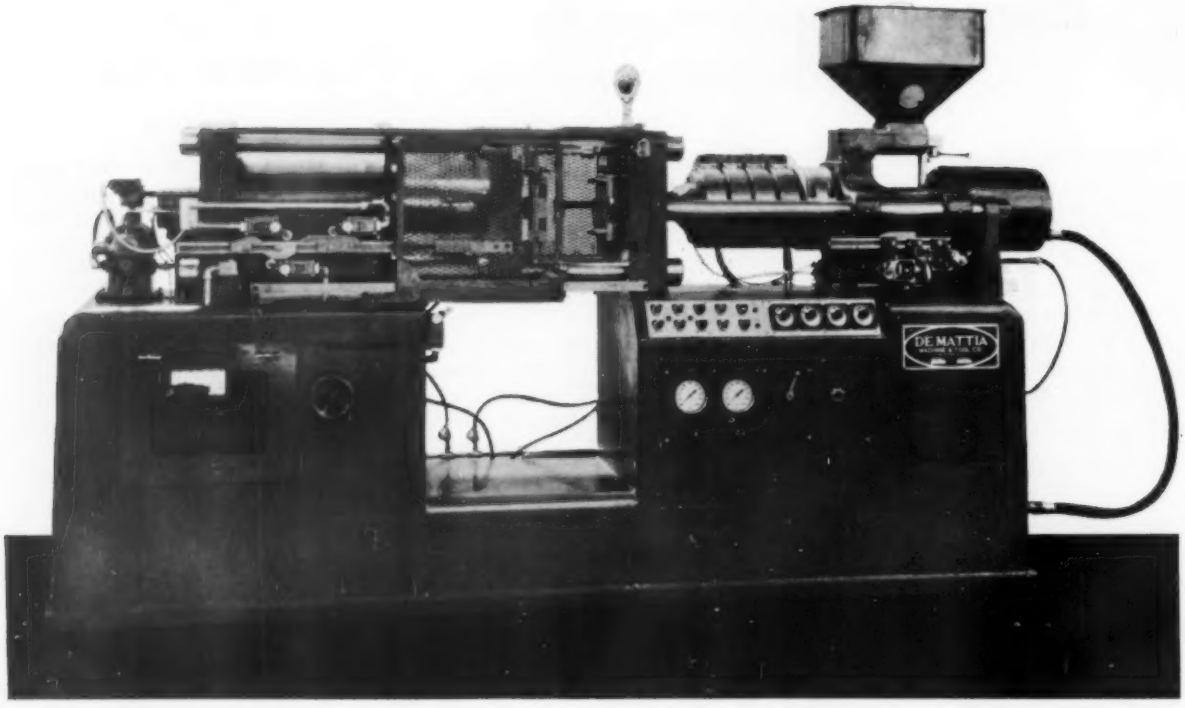

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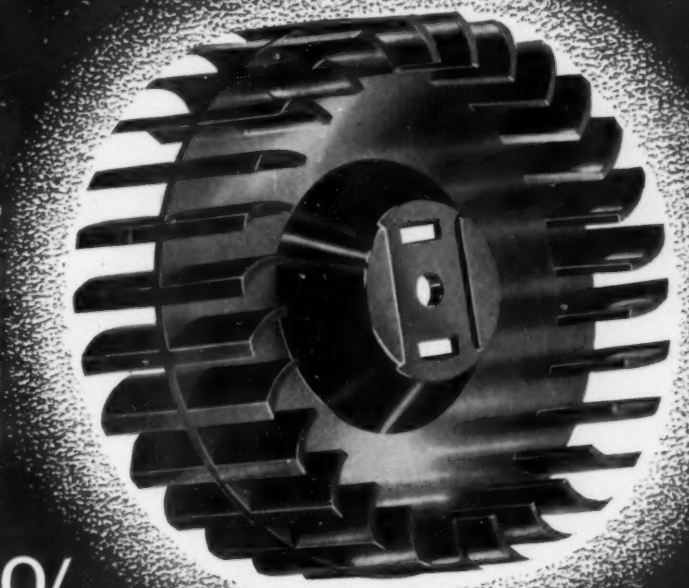


(actual size)
This turbin-type blower rotor is one of 34 parts made of Spencer Nylon used in the new, fully-automatic Anscomatic projector.

. . . WITH SPENCER NYLON

Solving tough injection molding problems is a challenge welcomed by Spencer Nylon. Advanced Spencer Nylon resins speed up production of even the most complex moldings. Here is an example . . .

The molder of the intricate 56-blade Anscomatic turbine fan shown above was able to reduce cycle time 40% by switching to Spencer Nylon 401-A. Altogether, 34 critical parts in this precision Anscomatic projector are made of Spencer Nylon. As a result, it costs less, weighs less, wears less and makes less noise.

The advantages of Spencer Nylon are many. Compared with other nylons, Spencer Nylon resins flow more freely to permit faster cycles and greater versatility of mold design. Because Spencer Nylon contains far less water, expensive drying time is unnecessary.

It will cost you nothing to discover the advantages of Spencer Nylon for yourself. Just contact us at the address below:

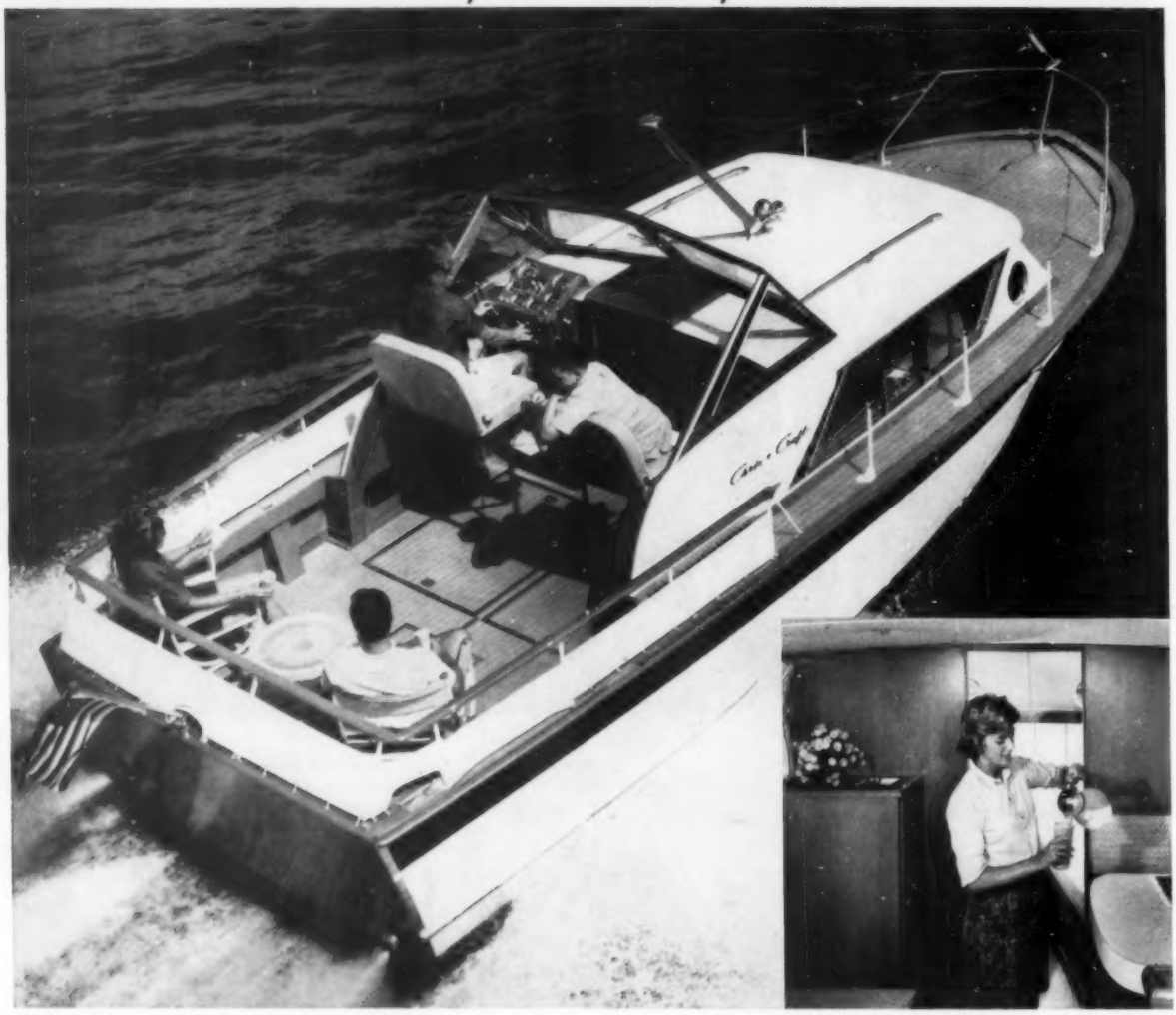
SPENCER®

SPENCER NYLON

SPENCER CHEMICAL COMPANY

Dwight Building . . . Kansas City 5, Missouri

COATED FABRICS EASE UPKEEP OF BOAT FLOORS, DECKS, CABIN TOPS



Nautolex covers decks and seats on Chris-Craft 28-ft. Constellation. Deck covering has handsome teakwood graining.

Interior upholstery of Chris-Craft 32-ft. Constellation is "breathable" Nautolex in all-over pattern. Ceiling overhead is white Nautolex.

The elbow grease is gone from boat maintenance. An occasional soap-and-water mopping keeps a new marine surfacing material called Nautolex® shipshape the year-round!

A tough Wellington Sears cotton duck is the base fabric chosen by the General Tire & Rubber Company for Nautolex. With a durable vinyl coating, it provides full protection against sun and sea, resists scratches and scuffs—is impervious to gasoline, oil, battery acids.

Proved to outwear other surfaces five to one, Nautolex is used by leading boat manufacturers—and is available by the yard for do-it-yourself boat-enthusiasts.

Wellington Sears has vast experience in engineering fabrics to specific jobs. When you need cotton or synthetic base fabrics, or fabrics for any other application, this experience is yours to draw on. Write for assistance—and our illustrated booklet, "Fabrics Plus," Dept. K-4.

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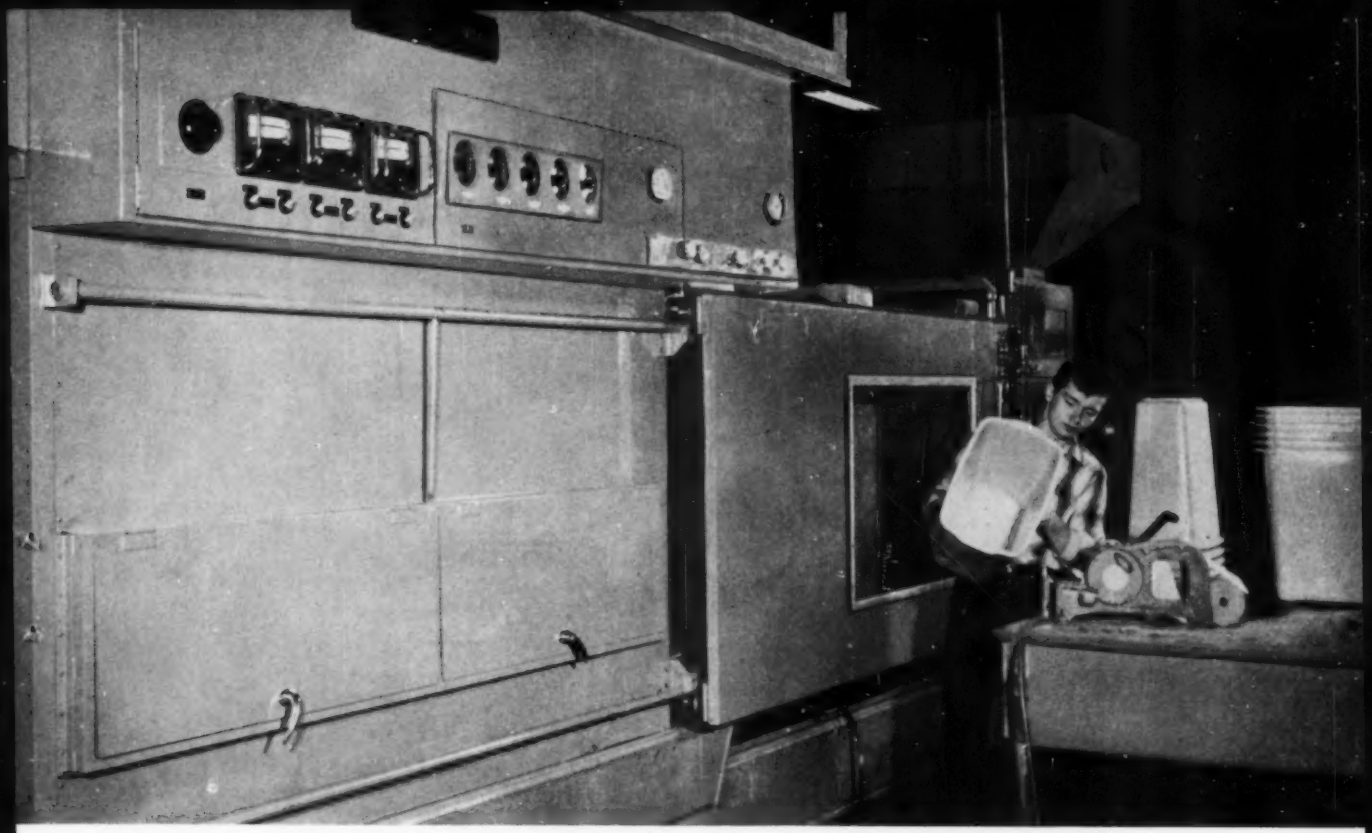
FIRST in fabrics for Industry

For coated materials, high and low pressure laminates and other reinforced products

Wellington Sears Company, 111 West 40th Street, New York 18, N.Y. • Akron • Atlanta • Boston • Chicago • Dallas • Detroit • Los Angeles • Philadelphia • San Francisco

*RTM The General Tire & Rubber Company



This high speed Natco 800-X molds polyethylene wastebaskets at Fesco.

"Eleven Big NATCOS Put FESCO Ahead in Housewares"

. . . Says George Oravec, Molding Supt., Federal Enameling & Stamping, Pittsburgh

"When we decided to establish our own Plastics Molding Division, we carefully investigated all makes of molding machines."

"We chose Natcos because they had proven best with our molds. Their ability to cycle fast and produce quality parts was a big factor in our choice. We're running our Natcos 24 hours per day . . . 7 days per week . . . with trouble-free performance."

Find out what these money saving Natcos will do for you. Write today. Stock sizes from 12 to 140 ounces. Ask for Bulletin 2001.

NATCO

THE MOLDER'S MOLDING MACHINE

NATIONAL AUTOMATIC TOOL COMPANY, INC.

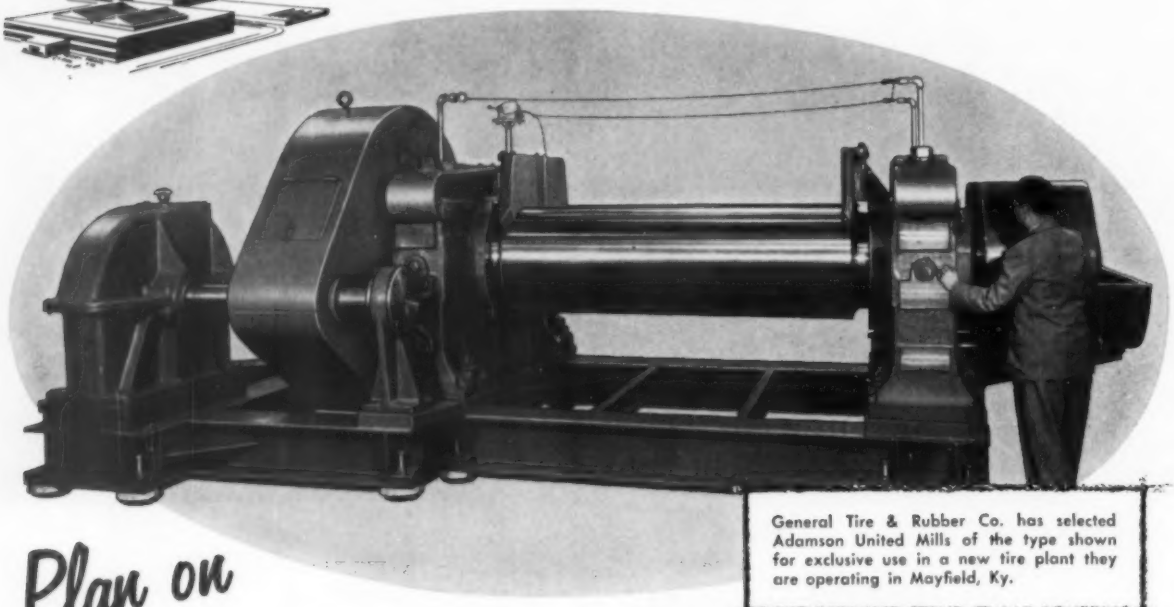
PLASTICS MACHINERY DIVISION

RICHMOND, INDIANA, U. S. A.

Whether you are planning on

EXPANDING or UPDATING

Your Mill Facilities...



General Tire & Rubber Co. has selected Adamson United Mills of the type shown for exclusive use in a new tire plant they are operating in Mayfield, Ky.

Plan on

ADAMSON UNITED MILLS

for rubber or plastics processing

Yes, whether your plans are for one mill or many, standard or special mills, Adamson United can meet your requirements with mills recognized industry-wide for high production efficiency and trouble-free operation.

Standard units are available in a wide range of sizes from 6″ x 16″ to 28″ x 84″, as well as special sizes and types to meet specific requirements. They can be supplied driven individually, in pairs, or in groups on a line shaft. When equipped with leveling-type vibration mounts with fabricated base as illustrated, or with hot-rolled steel plate base, costs of mill installation are substantially reduced . . . on a sturdy floor in good condition, no special foundation is required.

For other new installations Adamson United engineers have drawn on years of experience to produce new simplified mill units which combine only the most desirable design and operational features . . . the result being mills of highest quality offered most economically. Call on Adamson United to help plan **new** installations, or to update existing facilities. We welcome the opportunity to serve you.

7078

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common sense reasons why molders specify....

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Thermoplastic Molding Compounds

Peak quality at peak savings. Gering—pioneer in formulating superior thermoplastic molding compounds—offers the widest range of thermoplastics available from a single source. Quality control assures greater satisfaction through fewer rejects, faster molding cycles, and greater color uniformity. Write us today.

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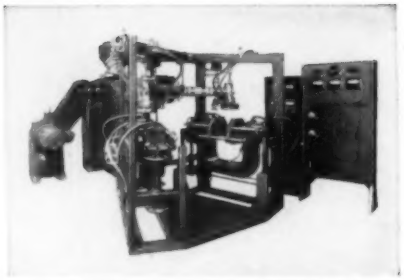
MPM doesn't sell merely extruders — it sells *production*. When you order an MPM extruder, you know exactly what caliber of performance you can expect, because you've seen it perform . . . had a chance to test every part before purchase.

Moreover, many extruders today are "patch-quilt" affairs: one piece made by this company, a second part by that, a third by still another. Not with MPM. For MPM manufactures virtually all its own components: grinds its own screws, assembles its own controls . . . all precision-built to MPM standards in MPM's modern, 90,000 sq. ft. plant.

Screw diameters available range from 1 to 12", in vented or non-vented design, and in L/D ratios of 20:1, 24:1 or longer Either resistance-band heaters, cast-in heaters or induction heating can be specified. Extra heavy-duty thrust bearings, Xaloy-lined barrels, and precision-ground screws are typical of rugged MPM components. In short, MPM extruders are tailored for your specific needs, then proved out to you before you buy. More information? Just write Modern Plastic Machinery Corporation, 64 Lakeview Avenue, Clifton, N. J.

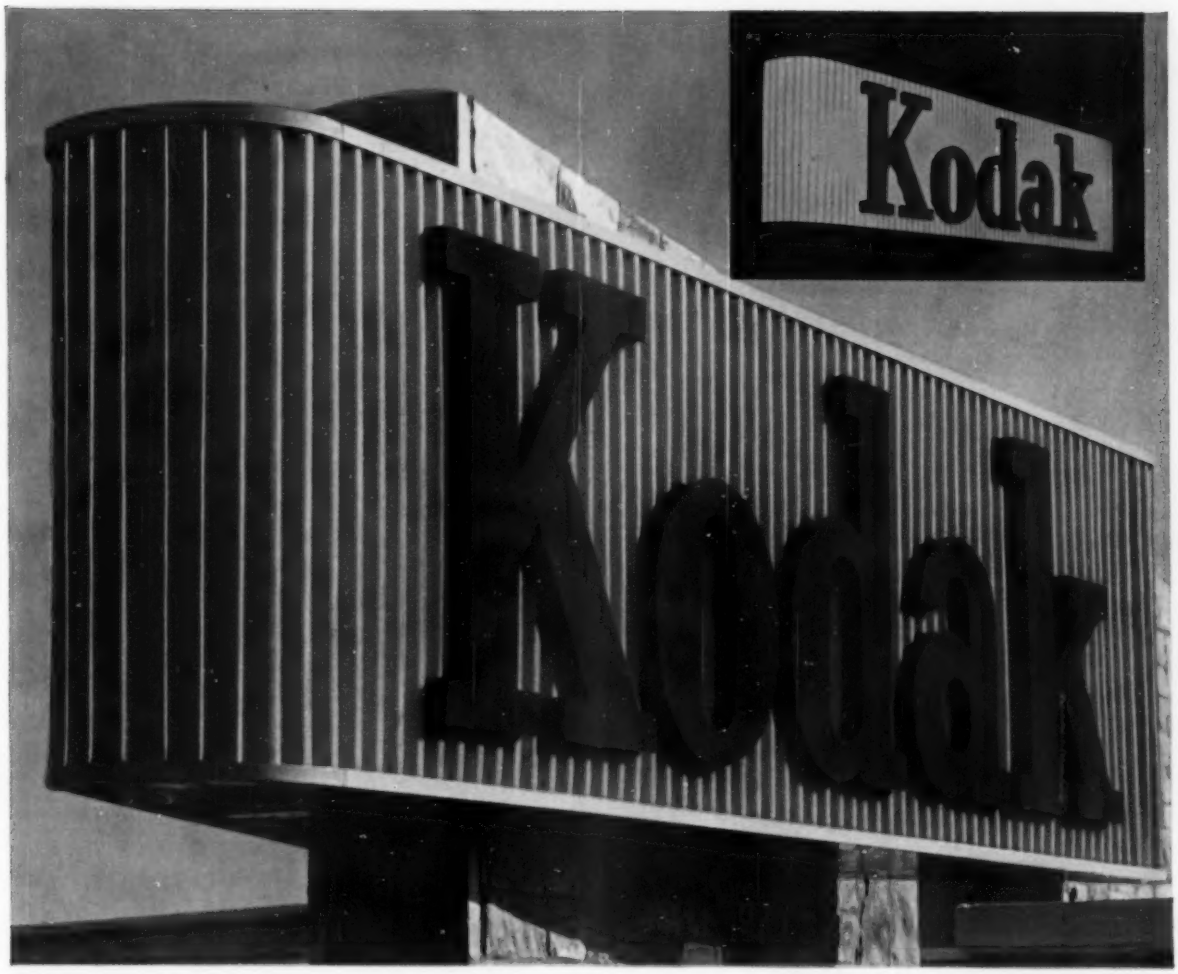


INTERESTED IN BLOW MOLDING? Then you'll be interested in the new MPM "Diversamatic." Molds from polyethylene, polypropylene, high-impact styrene, acetate, nylon, other materials. Handles molds up to 36" long, 21" wide, 28" daylight. 14" stroke. Automatic built-in electric counters. All-pneumatic system. Works with any extruder, either U.S. or foreign-built.

mpm **Modern Plastic Machinery Corporation**

General offices and engineering laboratories: 64 Lakeview Avenue, Clifton, N. J.

Day...or night... outdoor signs stand out in **BUTYRATE**



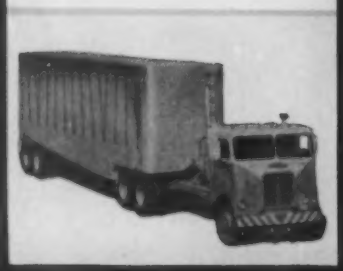
Sign manufactured by Triple A Neon Co., North Hollywood, Calif., for Eastman Kodak Company offices in Whittier, Calif. Background and letters made from sheet extruded by Jet Specialties Co., Inc., Los Angeles 63, Calif., from a special weather-resistant formulation of Tenite Butyrate plastic.

Internally lighted outdoor signs of Tenite Butyrate plastic sheet identify leading companies forcefully...tastefully... round-the-clock.

Unlike signs whose impact fades with the dusk or the dawn, signs of Butyrate are strikingly effective 24 hours a day, even in highly competitive locations.

Handsome outdoor signs are but one of many roles that Tenite Butyrate plays on the modern scene. You'll find this versatile Eastman plastic used for auto steering wheels, boat letters, fish lures, handles for garden tools, decorative architectural panels, underground pipe, and thousands of other products. If your product could use the benefits of a tough, colorful, weather-durable plastic material—either clear or colored transparent, translucent, or opaque—send for more information on the outstanding properties of Tenite Butyrate. Write EASTMAN CHEMICAL PRODUCTS, INC., subsidiary of Eastman Kodak Company, KINGSPORT, TENN.

TENITE®
BUTYRATE
an Eastman plastic



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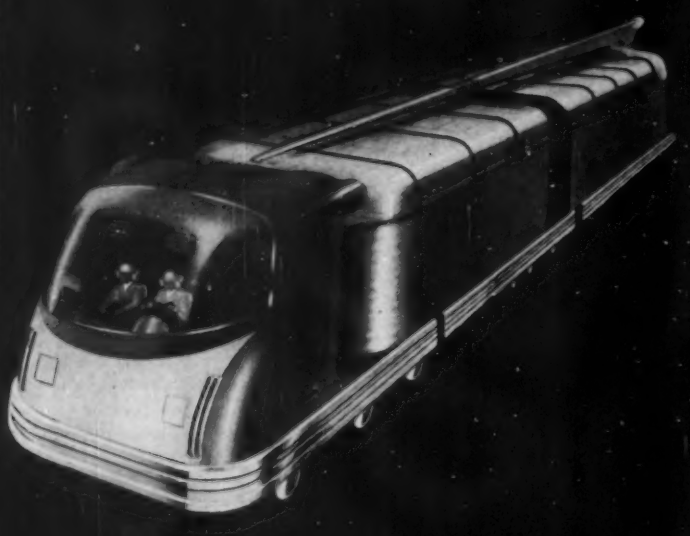

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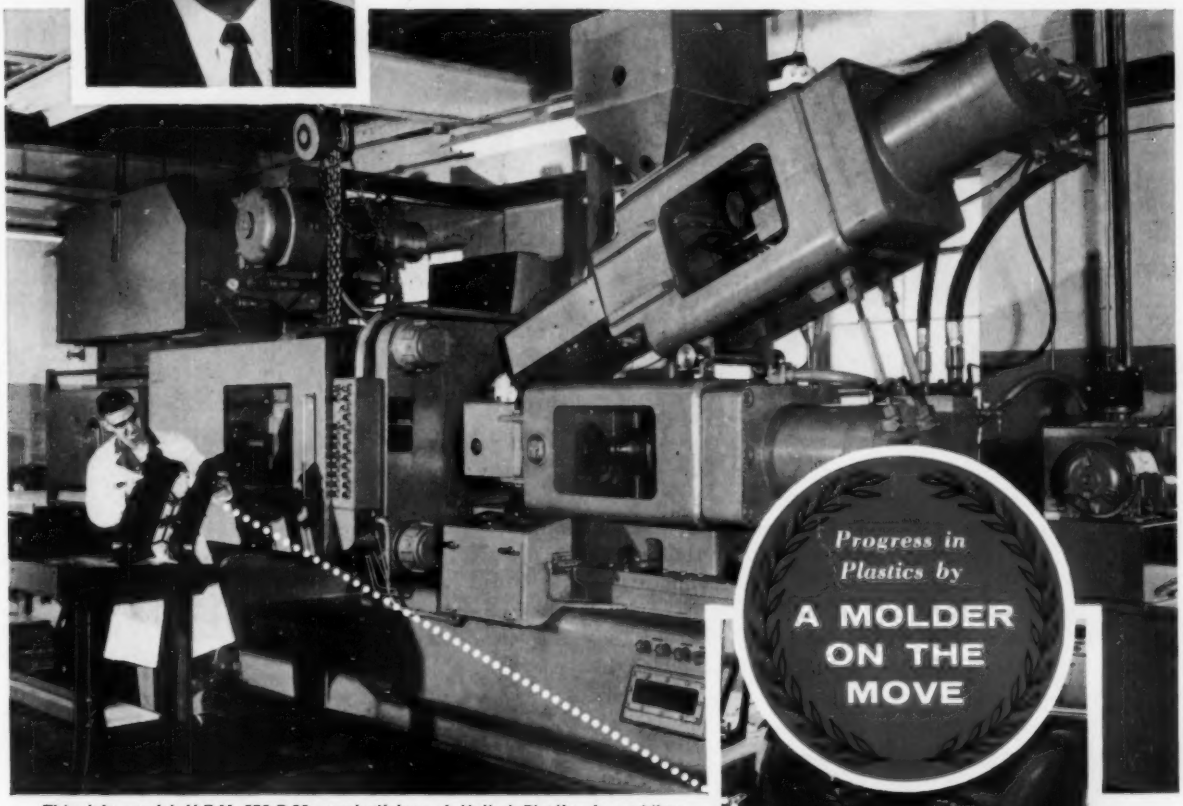
Photos courtesy of the White Motor Co. and ... and American Trucking Associations, Inc.

"We have been using H-P-Ms for most of the molded automotive parts produced at United. New car interiors reflect the good taste of the country's finest designers. Our injection molding must match high requirements for production, quality and good appearance. H-P-M provides the machines to produce efficiently and profitably for these difficult specifications. With our H-P-Ms we're ready for plastic's great future."

L. S. Brown, President
United Plastic Industries Inc.
Vassar, Michigan



This late model H-P-M 650-P-80 preplasticizer at United Plastics is molding both right and left seat side-shields in a two-cavity mold. This high-speed H-P-M (80 oz. capacity/650 ton mold clamp) is ideal for molding the tough jobs.

Quality moldings for prestige products

Among the many auto parts molded at United Plastics, the seat side-shield for Ford Motor Company's Thunderbird perhaps typifies what's going on in Detroit. IT'S PLASTICS — for COST SAVINGS . . . DURABILITY . . . LIGHT WEIGHT . . . GOOD LOOKS . . . WEAR RESISTANCE. It takes the best high speed machines to meet Detroit's rigid requirements for the plastic trend in automotive parts. H-P-M has paced the industry with respect to machine design and development. H-P-M has the greatest choice of machines, the longest job-proven success background and the broadest sales and service back-up. There's an H-P-M for every job, for every production requirement. You too, will be ahead if you start with an H-P-M. Contact us today.

Interior view 1961 Thunderbird by Ford Motor Company. Besides having smooth beauty, these seat side-shields are scuff-proof.

H-P-M
DIVISION
Koehring Company
Mt. Gilead, Ohio, U.S.A.

HPM H106

"PLASTICS PEOPLE" DON'T BLUSH...

when they're processed with Barber-Colman Controls

Even minor off-color "blushing" is eliminated when injection molders and extruders are Barber-Colman equipped. Barber-Colman Controls offer true color and accurate form through precise temperature control. And now, you can indicate temperature or pressure measurements on only one instrument with Barber-Colman's new 400 Series Capacitrols. Simply flip a selector switch to indicate the temperature or pressure. Also, you can record any combination of temperature and pressure up to 24 points with the new Series 8000 Recorders. Barber-Colman's wide ranging automatic process controls are the first choice in the Plastics Industry. Contact your nearest Barber-Colman, Wheelco Industrial Instruments Division office or write direct for complete information.

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Any combination of temperature or pressure recording up to 24 points. Separate 11" scales, up to six high or low limit switches, electronic potentiometer, swing-out chassis.

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Pressure and Temp. selector switch, 6" scale, direct reading, high or low limits.

SERIES 400
CAPACITROL — more accurate 6" scale, no-contact Electronic Link, sensitive, reliable, plug-in chassis.

MODEL 297
5" SCALE CAPACITROL
Accurate, rugged dependable, no-contact Electronic Link, plug-in components.

BARBER COLMAN

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IF PHENOLICS CAN DO IT, PLENCO CAN PROVIDE IT—AND DOES—FOR

the industrial control "*small*" talk is about the

CUTLER-HAMMER COMPACT 300

...new multi-pole relay permanently enclosed in a case molded with

You're looking at an entirely new class of control circuit relays . . . the *Compact 300* by Cutler-Hammer, Milwaukee, Wisc. This 300-volt 6-amp. unit is especially tailored to the needs of automation for components of reduced size, higher speeds, greater reliability. It takes up to 70% less panel area (24 poles can be mounted on the area a dollar bill occupies) and can operate twice as fast as many conventional relays.

To assure long-lived dependability, the design calls for a *complete enclosure*. Molded of tough, durable Plenco 407 Phenolic Molding Compound, the case protects internal precision parts against accidental damage and contamination. Why Plenco 407? Because it provides the ideal combination of dimensional stability, desirable electrical properties, superior mechanical strength, and heat resistance —*as specified* by Cutler-Hammer. Offers Cutler-Hammer production advantages, as well; superior flow, cure, and mold release.

Versatile Plenco phenolics have countless applications. Ready-made (as Plenco 407 is) or custom-formulated, there's a little Plenco in the best of things. A talk with our technical staff can demonstrate how *your* product can benefit.

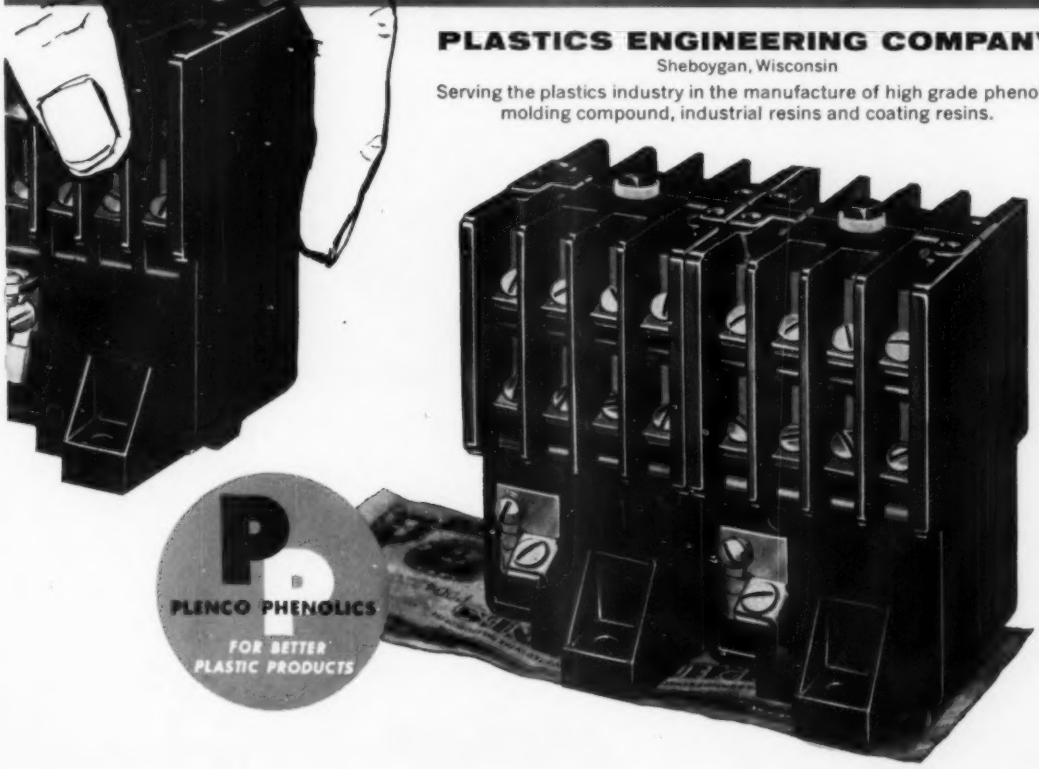
PLENCO

PHENOLIC MOLDING COMPOUNDS

PLASTICS ENGINEERING COMPANY

Sheboygan, Wisconsin

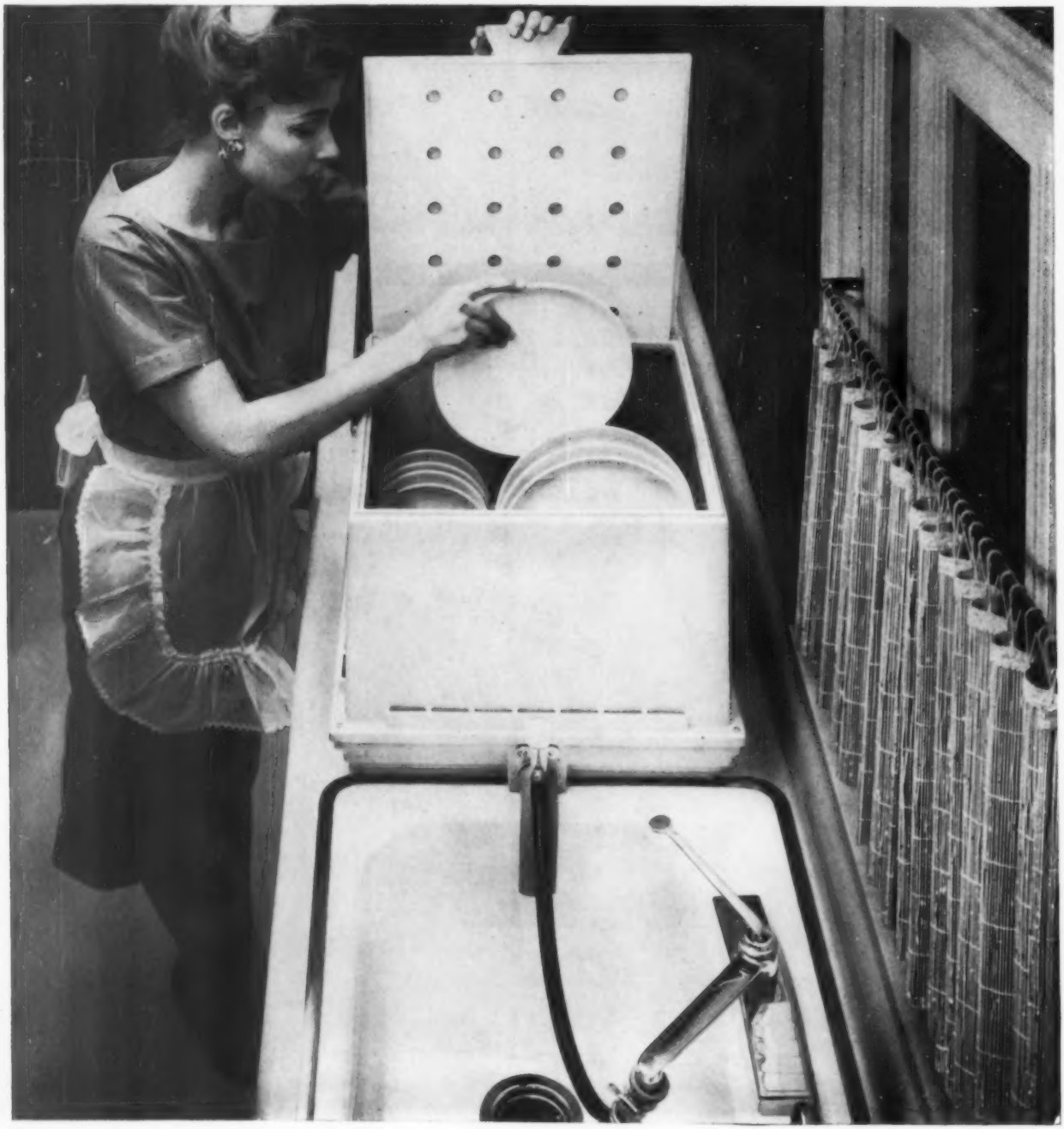
Serving the plastics industry in the manufacture of high grade phenolic molding compound, industrial resins and coating resins.



Portable dishwasher powered by kitchen tap

This 11-pound, portable dishwasher developed by Spaulding Industries, Inc., Chicago, Illinois, needs no power other than water pressure from a tap. Just set it on the sink, attach its hose to a faucet, and turn on the water. It washes and rinses completely in only 6-8 minutes.

The base, case and lid are molded from heat-resistant, high-impact DYLENE® polystyrene. The one-piece DYLENE base and lid have intricately molded vents that circulate cool air that dries dishes in a matter of minutes. DYLENE plastic is easy to mold in any permanent color, size or design. It won't flake, chip, peel or mar surfaces, and it's unaffected by harsh detergents and scalding hot water.



Foam plastic liner muffles disposer noises

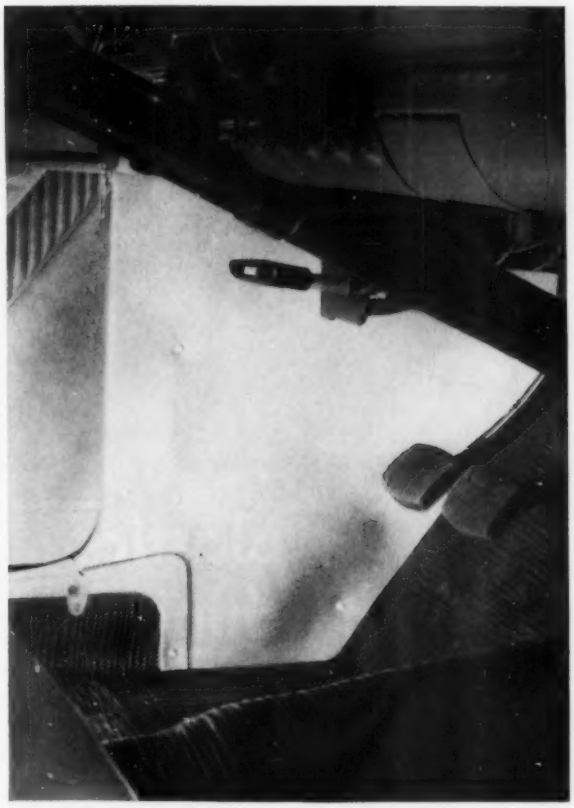
Designers at In-Sink-Erator Manufacturing Company knew they could increase sales of this new Gold Comet garbage disposer if they could make it work quieter. So they placed a molded liner of DYLITE® expandable polystyrene inside the unit. This rigid foam plastic muffles noises as the unit shreds food wastes down the kitchen drain.

DYLITE is strong, lightweight, water and vapor-resistant. It can be molded to almost any size, shape or color. This low-cost plastic is ideally suited for a wide variety of applications in protective packaging, low temperature insulation, flotation and refrigeration. DYLITE parts molded by: Stevens Plastics Products, Hebron, Illinois.

Trash cans that won't rust, rattle or corrode

Because it's polyethylene, these trash cans resist acids, alkalies, rust and corrosion, and even rough handling won't dent, chip or peel them. They're molded from durable DYLAN® polyethylene and available in beautiful permanent colors. Each trash can has a molded lid that locks tight and prevents spilling.

Koppers has a wide range of polyethylenes for almost any application. They are available in densities ranging from .914 to .953 gm./ml. By varying density, molders or design engineers can get varying degrees of stiffness, heat distortion and tensile strength. Trash cans molded for Sears Roebuck by G. A. T. X., Chicago, Illinois.



Plastic side cowls protect car interiors

Ford Motor Company now uses SUPER DYLAN® high-density polyethylene for interior side cowls on all their Falcon, Comet, Mercury, Thunderbird and Ford models. These cowls have replaced painted hardboard and fabric lacing. They last longer, look better, install easier.

SUPER DYLAN side cowls won't scuff, crack, chip or peel. They won't absorb water so they don't warp or discolor. Temperature changes won't bother them. They're easy to clean and their colors are built-in to last the life of the car.

KOPPERS PLASTICS

KOPPERS®

Find out how Koppers family of fine plastics can help improve your product at less cost to you. For more complete information, contact Koppers Company, Inc., Plastics Division, Dept. 145, Pittsburgh 19, Pennsylvania.

of equipment for

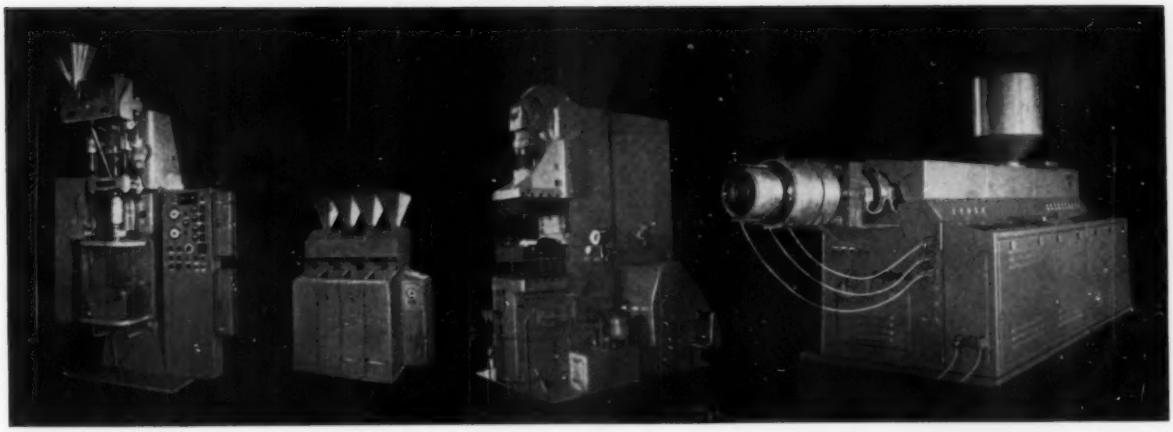
INJECTION MOLDING

COMPRESSION MOLDING

TRANSFER MOLDING

BLOW MOLDING

EXTRUSION



Blow Molding Machines
with piston and screw feed
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Automatic Serial Presses
for screw caps etc.

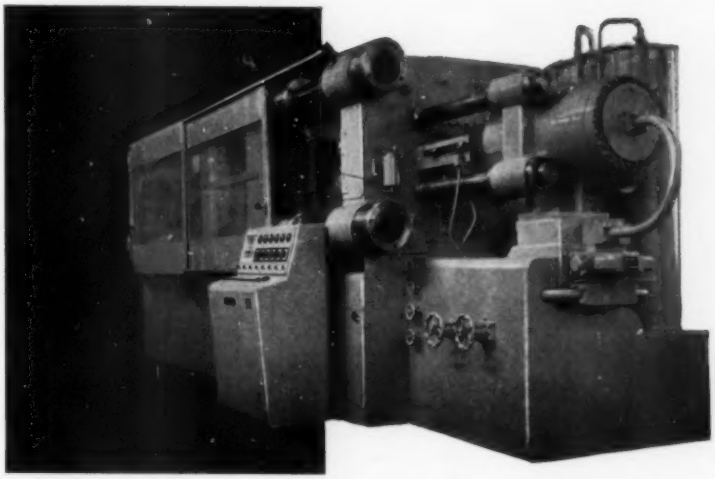
Compression and Transfer Molding Machines
up to 300 tons capacity

Extruders and complete Automatic Plants
(with screw diameters
1¼" 1¾" 2½" 3½" and 6" approx)

INJECTION MOLDING MACHINES

from 1/10 oz. upwards

with
SCREW PLASTICIZING UNIT
from 1 — 350 OZS



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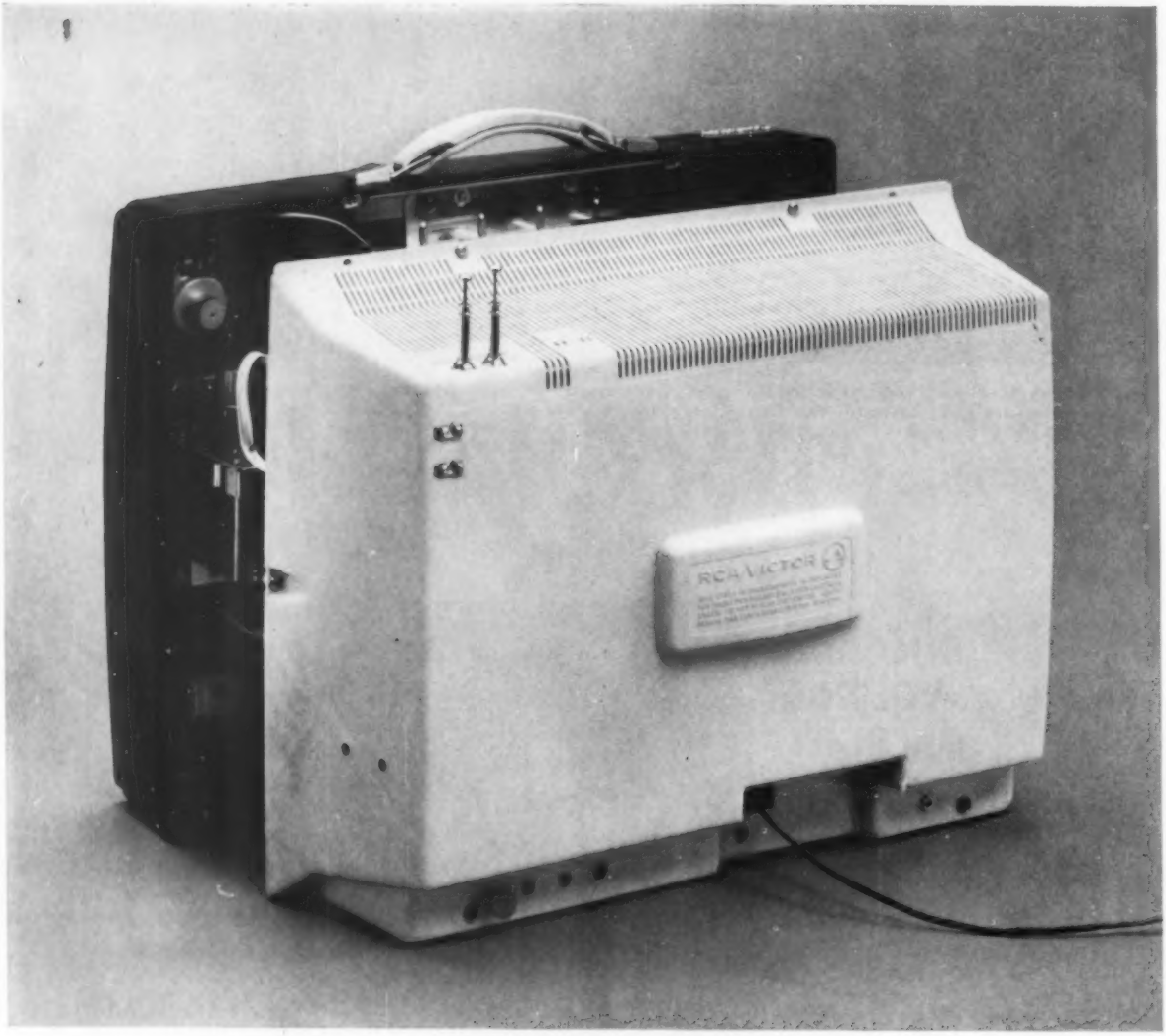

Escon® POLYPROPYLENE
resists heat distortion...at low cost

The backing for this new RCA television receiver is molded of Escon polypropylene in an attractive textured finish. RCA chose Escon because of its high heat deformation point and balance of other important properties. In addition, Escon polypropylene has excellent electrical properties and allows considerable design freedom.

Parts made with Escon polypropylene resist stains and are easy to clean. Colors can be matched easily. Cost of finished parts is lower than those made of any other thermoplastic material that can provide similar properties. For full performance data and complete technical assistance, write to Enjay at 15 West 51st Street, New York 19, New York.

EXCITING NEW PRODUCTS THROUGH PETRO-CHEMISTRY

ENJAY CHEMICAL COMPANY

A DIVISION OF HUMBLE OIL & REFINING COMPANY

ENJAY
PLASTICS

we'll make the press

YOU NAME THE MATERIAL CHARACTERISTICS

Just tell us the nature of the material—polyester, acrylic, fiber glass, rubber, or whatever—and give us your production specifications. We'll build the right compression molding press to meet your needs.

Erie Foundry regularly builds hydraulic molding presses in capacities of 25 to 4,000 tons. Our advanced design control systems will apply forces accurately and precisely, maintain platen temperatures within close tolerances, and perform molding cycles with split-second timing. Versatility is built in so that a wide range of molding jobs can be handled.

Write now for your copies of our descriptive bulletins on Erie Foundry hydraulic presses for rubber and plastics.

Hydraulic Press Division
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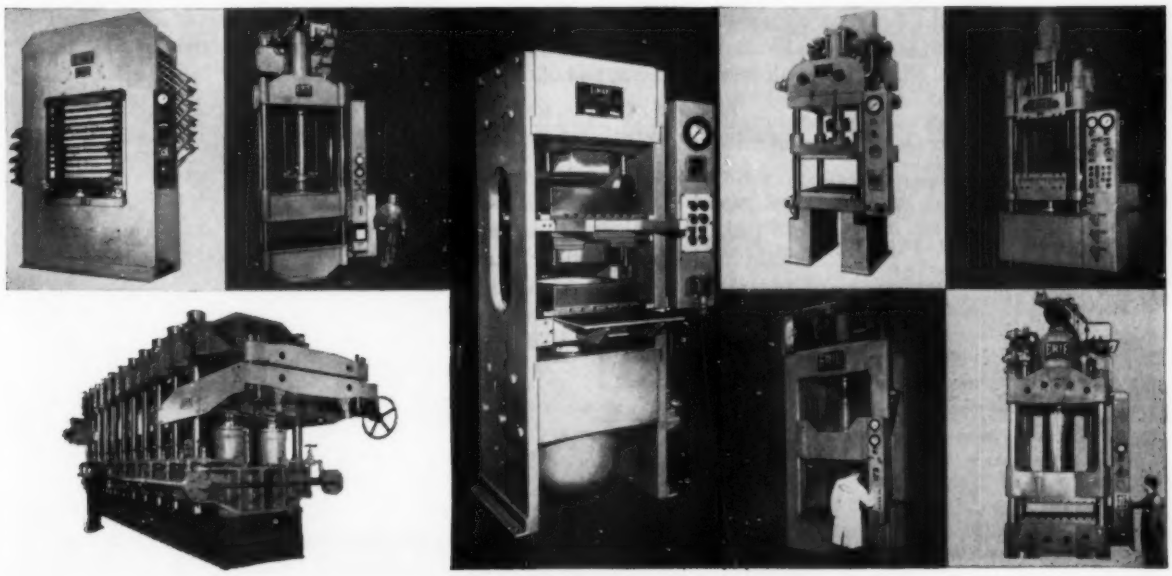
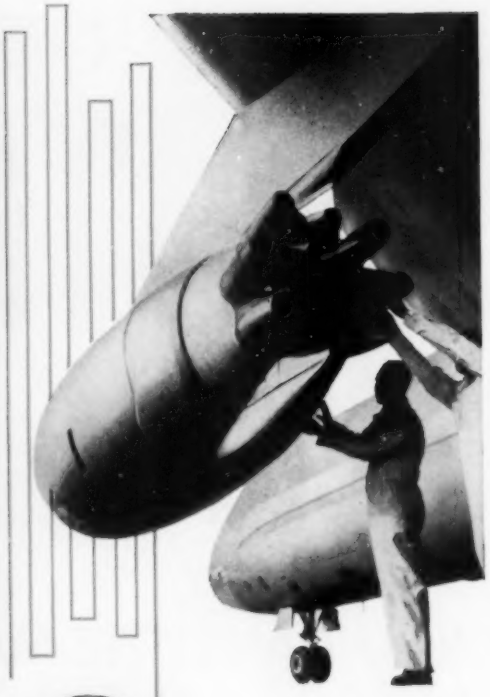


Solving unusual problems with Riegel papers

Porous Papers



for choosy filters...

Could we make a porous paper that would pass oil but stop water? Was there a way to make paper containing large quantities of activated charcoal?

No "curved balls," these questions. They're typical of today's serious search for high performance filters to improve your life, machines or processes . . . disposable filters obtainable *at the cost of paper*. Both the oil-water and the activated charcoal filter papers have already been solved by Riegel researchers; both are now in production.

Also solved by Riegel: Gas-aerosol filters to trap atomic fallout; fuel filters for jet engines; gas masks; filters for automotive lubricating oil and air intake systems; and of course, vacuum cleaner bags.

These are not ordinary papers. They're highly specialized papers, with qualities of strength, resistance to water or solvents, and precise porosity.

Riegel specializes in developing, manufacturing and converting technical papers that solve problems. Our paper machines are specially designed to make unusual products; our auxiliary equipment includes facilities for resin impregnating and/or coating to custom specifications. We have wide experience with natural fibers (asbestos, rope, jute, cotton, esparto and wood) and man-made fibers (nylon, acrylic, polyester, vinyl, glass and rayon). If you have any idea for doing something in a better way . . . with a better paper . . ..

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- Release papers for pressure sensitive adhesives
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Riegel

TECHNICAL PAPERS FOR INDUSTRY

"This troublesome mold proved
the **24/32 OUNCE LESTER**
gives us an edge over competition"

"This Tonka Tanker was being tested in other shops on 30 to 40 ounce equipment. The only way it could be run was on a prohibitively long cycle. Anything less, resulted in short shots, weld and sink marks and other finish problems. The job was so tough to run that the mold was suspected of being poorly engineered," says Bruce Schroeder of Empire Plastics, Inc., in Loretto, Minn.

"We put the mold on the L-500-24/32 ounce machine in our all-Lester shop and it took off at 60 shots per hour, running 21 ounces of Implex, a hard-flow, viscous, modified acrylic. The finish was perfect and we got a full shot every time."

The 24/32 ounce Long Stroke Lester with 500 tons of Certified Clamp and adjustable mold stroke of 8″ to 30″ is daily meeting the demands of capacity, clamp and stroke for big, tough jobs up to 40 ounces. Detailed specifications are available on request.

LESTER ENGINEERING CO. CLEVELAND, OHIO 25th ANNIVERSARY

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Agents in principal cities throughout the world

WEIGHT-BEARING WAYS —The Ingersoll Milling Machine Company, one of the largest builders of specially designed machine tools, are particularly well known for their milling and boring machines. These machines are built in a range of sizes up to mammoth proportions. The phenolic laminated plastic ways shown above are used at the bottom of machine tables to prevent scoring of metal-bearing surfaces under their heavy loads. The plastic ways also reduce fitting time. Some of these machines have a capacity for carrying upwards of two hundred tons on the table in addition to the weight of the table. The laminated plastic ways were supplied by the Panelyte Division of St. Regis Paper Company and made with Mount Vernon Duck.

This is another example of how fabrics made by Mount Vernon Mills, Inc. and the industries they serve, are serving America. Mount Vernon engineers and its laboratory facilities are available to help you in the development of any new fabric or in the application of those already available.

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U.S.I. POLYETHYLENE NEWS

A series of advertisements for plastics and packaging executives by the makers of PETROTHENE® polyethylene resins

APRIL, 1961 — U. S. Industrial Chemicals Co., Division of National Distillers and Chemical Corporation — 99 Park Ave., N. Y. 16, N. Y.

Packaging Notes

Liquid-tight carton with built-in liner of polyethylene-coated paper requires no overwrap. Heat sealing, hot-melt

Wrapless frozen-food carton developed on West coast has polyethylene-coated paper liner which interlocks with flaps on folding. Subsequent heat sealing and gluing complete liquid-, vapor-tight closure.

adhesive and unique design of package all contribute to leak-proof closure. It has proved commercially acceptable for packaging frozen strawberries.

According to the company adopting it, this folding box and special integrated machine which opens, fills and seals it have boosted production speed substantially. Furthermore, it reportedly costs less, is easier to open and provides a better barrier to transmission of water vapor than the metal-end fiber can it has replaced.

Polyethylene squeeze bottles for cosmetics, and toys and Christmas ornaments are now being finished by a new vacuum

metallizing process. Result is an adherent metallic coating—with a texture—which reportedly withstands many squeezings and takes printing without pre-treatment. A choice of colors is available.

According to the developer, process is competitive in cost with ordinary plastics metallizing.

Clams-in-the-shell have joined the growing list of polyethylene-packaged, individually quick-frozen foods. Whole frozen clams are now available on the west coast in 7½" x 13", 3-mil polyethylene bags. According to the marketers, polyethylene was selected for packaging because "it is relatively inexpensive and controls breakage."

DO YOU HAVE a new polyethylene product or development you'd like the industry to know about? Make it routine to send your information on new developments to U.S.I. POLYETHYLENE NEWS.

Address:
U.S.I. POLYETHYLENE NEWS, U. S. Industrial Chemicals Co., Division of National Distillers and Chemical Corp., 99 Park Avenue, New York 16, N. Y.

U.S.I. Announces Plans to Produce Linear Polyethylene

Will Build 60,000,000 Pound-Per-Year Plant at Houston, Texas

U.S.I. will begin construction this Spring on a 60 million pound-per-year linear polyethylene plant at Houston, Texas, adjacent to the company's conventional polyethylene facilities. The new plant, which will mark U.S.I.'s entry into the manufacture of linear polyethylene, is scheduled for completion in the fourth quarter of 1962.

Recently there has been considerable discussion about over-capacity in the linear polyethylene field. Dr. Robert Hulse, general manager of U.S.I., states: "We would not be building this important new plant if we did not believe that over-capacity is a short-term problem and that linear polyethylene is growing in importance. Every market projection we have made indicates that this versatile plastic will be in short supply by early 1963."

PETROTHENE® Trade Name to Be Used

The new U.S.I. plant, designed for easy expansion, will be managed by the same people who are now running the low and medium density polyethylene plant at Houston. The linear polyethylene will be manufactured under a licensing agreement with Phillips Petroleum Company, and will be sold under U.S.I.'s trade name, "PETROTHENE®" polyethylene resin.

Linear polyethylene is stronger and more rigid than the conventional type. It is widely used for blow-molded bottles and containers for industrial products, detergents and other household staples. Other growing markets include injection molded items such as toys and housewares; extruded pipe; and film for heavy duty bags and similar products.

Company Makes Wide Range of Resins

U.S.I. facilities for conventional polyethylene have a rated capacity of 300 million pounds annually. The company currently produces some 100 types of 36 basic low and medium density resins at plants in Houston and Tuscola, Ill. Linear resins are also currently available from U.S.I. pilot plant facilities and through resale arrangements.

New Resins, Equipment Featured By U.S.I. at Packaging Exposition

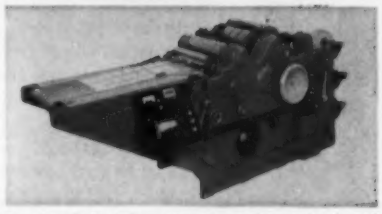
An array of packaging, injection molding and bag-making machines *in action* will be U.S.I.'s main attraction in Booth 1112 at the 30th National Packaging Exposition, April 10-13, at Chicago's Lake Front Exposition Center.

In operation will be three See-Safe packaging machines, which automatically package objects in polyethylene film from slit roll stock. This lineup will include: the Model MA, packaging free give-away items; the MA Jumbo, packaging large products in one step; and the brand new MA-T tilt-top machine, pouring and packaging small parts.

New Bag Making and Injection Molding Machines

Two Conapac machines will also be featured. The "Roto Poly-200", a high-speed heavy-duty machine, will be making bags from blown polyethylene tubing. It has a capacity of up to 200 cycles/min., operates at speeds up to 175 ft./min., and is reportedly the first which can handle *any* density polyethylene film. The "Rotojet" Model T5 will be injection molding small polyethylene containers. Said to be the first rotating turret type machine to appear in this country, it operates at speeds up to 50 shots/min., uses 8 single-cavity molds.

For extruders, converters and packagers of produce, soft goods, hardware or toys, the highlight of U.S.I.'s exhibit will be a new PETROTHENE polyethylene resin. Film extruded from it *combines maximum clarity and gloss with high impact strength, and offers optimum performability as well.* Samples and complete technical data will be available



The See-Safe MA automatic packager (top) and Conapac Roto Poly-200 bag maker are 2 of 5 new machines U.S.I. will feature at the show.

for this and all other PETROTHENE resins.

On display, too, will be samples of polyethylene-coated kraft, foil and cellophane. And, a variety of containers—including bottles produced from new PETROTHENE blow-molding resins. Of particular interest will be the 5-gallon collapsible jug just put on the market.

U.S.I. technical representatives will again answer questions and talk over polyethylene packaging innovations. Visitors are urged to use this opportunity to get expert help on specific problems.

U.S.I.

Series VI, No. 2

POLYETHYLENE PROCESSING TIPS

HOW TO PREVENT RESIN CONTAMINATION IN YOUR PLANT

Contamination in polyethylene resins can mean increased down-time and lower product quality. Both are costly results which can be prevented by a few simple precautions in handling and processing resin.

The producer, of course, has the responsibility to make sure that resin arrives at your plant in virtually contamination-free condition. U.S.I., for example, carries out strict quality control sampling of every PETROTHENE® polyethylene lot produced at its Tuscola, Ill., and Houston, Tex., plants. Engineers also maintain a constant check on production and handling facilities to detect possible sources of contamination before they can cause trouble.

Once the resin arrives at the customer's plant, it is his responsibility to prevent contamination during handling and processing steps. This is relatively simple if he follows the basic procedures outlined below.

Check the Container

There need be no question about the purity of PETROTHENE resin arriving at the processor's plant if the container is *sealed*. While all due care is taken in packaging and loading resins, some container breakage may occur.

Resin in containers arriving either broken or opened should not be used unless it is definitely established that no contamination has occurred. Instances of opened or broken containers should be reported immediately to the nearest U.S.I. sales office. This can help U.S.I. in determining where the breakage occurred and preventing its happening again.

In-Plant Conveying

Polyethylene resins are transported from their point of arrival in a processor's plant to the processing machine in a variety of ways. Which method is used depends on the type of container the resin is in and the size and type of processing operation involved.

In large operations, where Dry-Flo* carlots of resin are used, conveying systems are usually installed to move the resin either directly from the car to the processing machine, or from the car to storage silos, and eventually, to the processing machine. Where this is the case, the conveying system should be inspected regularly for loose fitting sections or other possible contamination entry points.

Hopper loaders of one type or another must be used with Sealdbin† shipments of polyethylene resin. These loaders should be designed to eliminate resin hang-up and checked regularly for possible points where contaminants can enter.

An important rule to remember is that any resin loading system should be closed. Resin containers or equipment hoppers which remain uncovered for long periods of time are a major cause of resin contamination.

Opening Bags

Most U.S.I. PETROTHENE polyethylene resin is shipped in 50-lb. multiwall paper bags. The inner ply has a coating of polyethylene to protect the resin from contamination by paper fibers, moisture and other foreign matter. Unfortunately, unless the bag is opened with care, bits of foreign matter may get mixed in with the resin.

First step before opening a bag is to brush the top section of the bag clean of any loose dirt and dust. Usually there is some, as this is unavoidable in shipping and storage.

Do not use a knife to open a bag. This will lead to contamination by paper fibers. The proper way is to open the bag by pulling apart the strings used to close its top after filling. The simple procedure for opening the bag is described in the data sheet, "How to Open a Polyethylene Resin Bag", which can be obtained from U.S.I. on request.

Opening Cardboard Containers

Cardboard containers of PETROTHENE resin are sealed with metal bands. In opening these containers, too, it is important to first wipe the top to remove dirt and dust which may have accumulated. As in the case with 50-lb. bags, cardboard boxes should never be opened with a knife. The proper method is to cut the metal bands and remove the container lid. The polyethylene liner found inside all U.S.I. cardboard containers should then be unfolded and placed over the top edge of the box before discharge of the resin. This liner helps further to protect the resin from contamination between charges to the processing machine hopper. The liner should be used to recover the unused resin before replacing the container lid.

Good Housekeeping

Even when all the above precautions are taken, some resin contamination may result from poor shop housekeeping. Processing areas should be kept clean so that dust and dirt, which can contaminate the resin during the brief intervals when it is uncovered, are kept to a minimum. A dirty processing area will always cause some degree of resin contamination, regardless of other steps taken to prevent it.

The last place where resin contamination can occur is in the processing machinery itself. Since this "Processing Tip" is primarily concerned with eliminating foreign material in the resin cubes and pellets, listing good processing practices in detail is beyond its scope. It is important to remember, however, that regular maintenance and cleaning of processing machinery not only will prevent resin contamination but also will insure optimum machinery and resin performance.

*Registered trademark of General American Transportation Corporation.

†Registered trademark of United States Rubber Co.

U.S.I. INDUSTRIAL CHEMICALS CO.
Division of National Distillers and Chemical Corp.
99 Park Ave., New York 16, N. Y.
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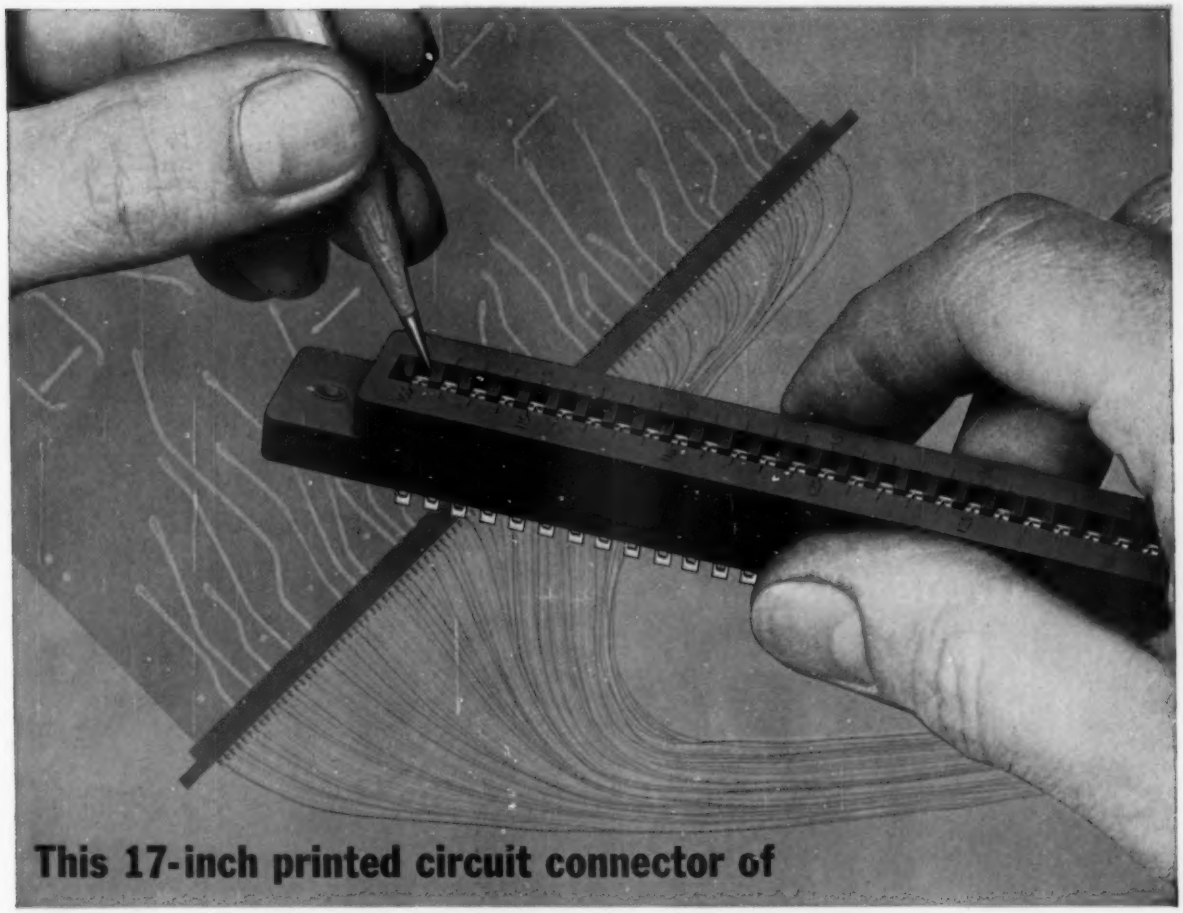

This 17-inch printed circuit connector of

DAPON® M OPERATES AT 450° F...
DIALLYL ISOPHTHALATE
STOPS WARPAGE AND MISALIGNMENT

Dimensional stability of compounds based on DAPON M keeps this connector straight and true: contacts are always accurately positioned.

This long connector is home base for hundreds of terminals. By molding it of thermosetting compound based on DAPON M, Viking Industries Inc. solved a number of design problems . . .

DAPON M gives the connector outstanding electrical and mechanical qualities. The resin permits 450°F continuous operating temperatures, has excellent dimensional stability and resistance to moisture. Its electrical resistance (measured in millions of megohms) remains unaffected by weeks of exposure to 100% relative humidity.

The material is easily molded. It has good hot strength, the piece is strong when cured. Neither cooling jigs nor multiple ejector pins are needed in removing the connector from the mold. Fast cycles are possible. The resin's high flex, tensile, and compressive strengths result in rugged moldings with high insert holding power and dependable performance.

DAPON M is recommended for use wherever:

- high operating temperatures are encountered
- top electrical qualities are a must
- better strengths are desired
- molding conditions pose a problem.

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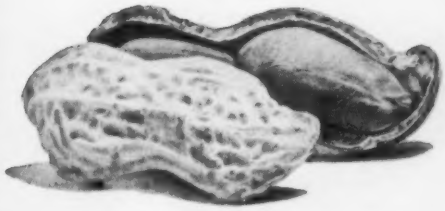

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Science for the world's well being

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CHEMICAL DIVISION

PRODUCT-DESIGN BRIEFS FROM DUREZ

How idea-men are using Hetron® in

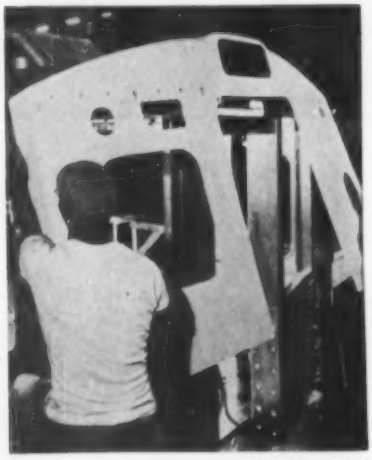
- **subway cars**
- **electrical laminates**
- **shapes with baked finishes**

Light—and tough

Philadelphia expects to save $6.5 million over the 35-year life span of its 270 new subway cars.

Built of stainless steel and with one-piece end sections of glass-reinforced Hetron polyester, the new cars save on power because they weigh about three tons less than conventional cars.

They won't ever need painting. End sections are dent-proof and virtually shatterproof. The Hetron material retards fire, and corrosion isn't expected to be a problem.



THE BUDD COMPANY

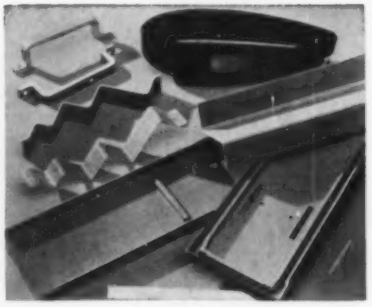
Ends of the cars were made by hand layup at Modular Molding Corp., which delivered the first unit just one month from start of tooling. Section thickness and rigidity were controlled by adding extra plies of fibrous glass where needed during layup. Gray metallic color was molded in.

Hetron is tough enough for just about any structural assignment you want to give it. Its inherent fire safety—without loss of other physicals—qualifies it for many jobs other polyesters can't do. It's used in DEW-Line radomes, U.S. Navy craft, Coast Guard-approved lifeboats.

For arcs and sparks

These dielectric laminates come in flat sheets or formed to many shapes. They are strong enough to play a structural role in heavy-duty electrical equipment.

The ones you see here are made with Hetron polyester resin by Fiber Glass Industries, Inc., and are inherently



flame retardant. Hetron burns only in actual contact with an arc or hot flame, and quickly extinguishes itself when the heat source is removed. Thus in case of a burnout, damage is usually confined to a small area, with minimum effect on mechanical strength of the material.

Generally, Hetron-and-glass laminates exhibit very low loss factor over a wide range of frequencies. Dielectric constant, for a ⅛-inch glass-mat laminate containing 35% glass, hovers as low as 4.25. Arc resistance of such a laminate is on the order of 110 seconds.

Do these traits suggest a way to achieve long life in equipment handling medium and high voltages? We'll be glad to discuss it further with you.

No craze

"Craze" is a nasty word in those circles where reinforced plastic parts are finished by painting.

Sometimes tiny surface cracks show up on otherwise perfect parts as they emerge from the drying oven. Often, the fault is in the base material, not the finish. Some reinforced plastics just aren't meant to take a 90-minute bake at 350° F.

This problem is being solved neatly by a good many knowledgeable people who specify *Hetron 32A* polyester resin for molded parts that must be painted and then baked.

Such a part is this outboard-motor shroud, produced in matched metal dies. Reinforced polyester makes a good shroud, because it muffles the motor noise rather than vibrating in resonance with it. Notice the smoothness of the baked-on alkyd finish? That's Hetron 32A under there. No craze.

Idea-file gives full information on Hetron resins. Covers uses, advantages, properties, methods of fabrication. Includes names of leading custom fabricators making panels and molded articles. To get a copy, just clip this coupon and mail to us with your name, title, company address.

DUREZ PLASTICS DIVISION

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LOOK AT GLASS FIBRE

The technician in the photograph is taking a careful look at E-Glass fibre—measuring its elasticity. Personnel in our Research Laboratories study the behaviour of glass fibre under varying environmental conditions—continuously measuring, testing, experimenting with the material. The careful and painstaking research undertaken in these laboratories is just one of the safeguards which guarantee the high quality of all Deeglas products.

It will pay you, too, to look at Deeglas—to find out more about it—to investigate its cost-cutting, product-improving qualities. Send now for a free copy of "Deeglas—Versatile Fibre of the Future"—it contains a wealth of interesting data about the complete Deeglas range of glass fibre reinforcing materials.

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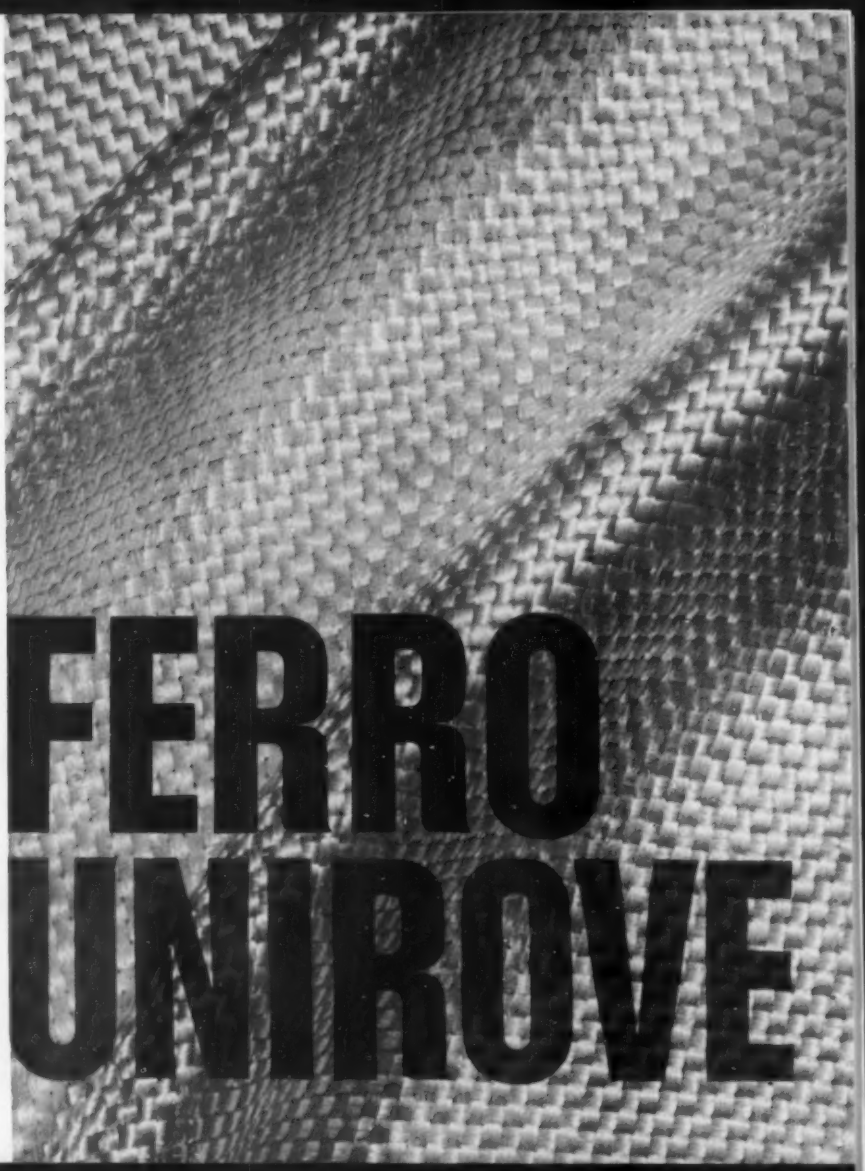

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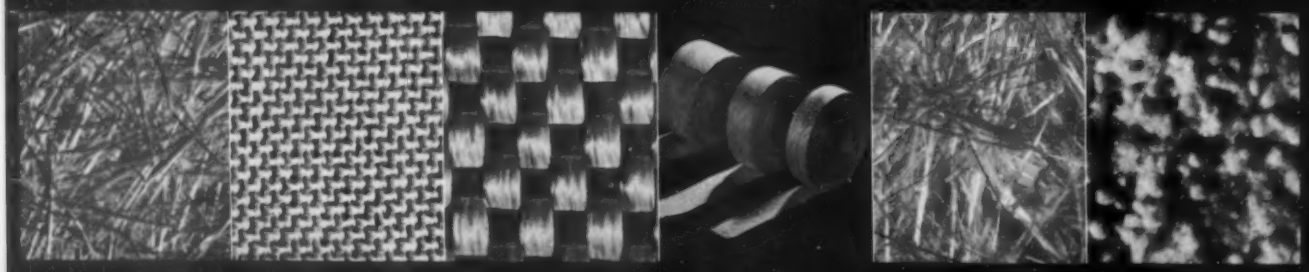

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THE PLASTISCOPE*

News and interpretations of the news — By R. L. Van Boskirk

Section 1 — April 1961

More plastics competition for metal

The recent announcement by Celanese of a new formaldehyde-based copolymer material called Celcon is further evidence that plastics are moving into the metals market in ever-increasing volume. It is also further evidence that the long locked-up mystery of how to polymerize formaldehyde for commercial applications has been solved, and that the material may now begin to take its place in an even more important role in thermoplastics than it has in the thermosets branch of the plastics industry.

It is almost impossible to emphasize fully the importance of these acetal resins to the plastics industry. They are built to order for direct competition with metals in many applications and will eventually become fairly low-cost materials. Delrin, introduced a year ago at 90¢, is already down to 65¢; Celcon's introductory price for pilot plant quantities is 70 cents. Specific gravity of Celcon is 1.410, Delrin's is 1.425. Both are lower in cost than brass or zinc when measured on a cost per-cubic-inch basis.

The entrance of Celanese into the field now gives added impetus to a remarkable promotion program for this type material started by Du Pont several years ago. It is as though a Ford had been the only low-cost car on the market for years and then along comes a Chevrolet to offer competition. Both of them manage to do pretty well.

Celcon has not been available long enough for an interested consumer to judge what differences there may be between the two materials and other "engineering type" plastics, but following are some of the Celcon properties as pointed out by a Celanese spokesman.

Celcon properties: It flows as easily as cellulosics, with a molding temperature range of from 370 to 440° F., which in some cases could go up to 480 or down to 350° F. In other words, it doesn't degrade easily and thus gives the molder a wide operating range. Tests indicate that molded Celcon does not lose shape up to within 10° of its true softening point, which implies a minimum of built-in stress. It can be coated on wire without danger of decomposition from copper. It can be boiled in 50% caustic at 280° F. without effect after long exposure, and is claimed to be usable as drain pipe without any effect from lye. In all these specific properties, it is claimed to be superior to polycarbonates, ABS, and other acetals.

It has other properties of acetals, including high heat resistance, negligible water absorption, little mold shrinkage, long-term resistance to creep even under load; and, of course, great impact strength. A highly interesting property is its resilience or "spring," which leads some observers to think that the long-sought plastic spring may eventually develop from this material.

Uses for Celcon: Among these are plumbing for homes, some of the half-billion lb. of die-cast zinc parts now used in autos, blow-molded containers, gears and bushings, appliances, pump housings, hose couplings, and a host of replacements for other die-cast zinc, aluminum, brass, copper, and steel parts. It may also replace wood for such uses as textile bobbins, tripod legs, and furniture parts. A Celanese spokesman said acetal resins may **(To page 43)**

*Reg. U.S. Pat. Off.

CAMPCO
Plastic Sheet and Film / *some practical IDEAS for its use in PACKAGING*

Skin packs of Campco Butyrate solve pen display problem

Lindy Pen Company of Culver City, California was faced with the problem of providing retailers with a method of displaying their varied line of pens in a way that was neat, attractive and easy to maintain. The solution was found in skin packaging—using Campco Butyrate Plastic Sheet.

Adds Impact To Displays Skin packaging makes possible highly visible, multi-unit displays of Lindy's line of pens and refills—helps to give them a related appearance for added impact at the point of purchase. Important packaging economies also result, since the backing cards are printed with complete sales information, eliminating the need for additional printed inserts.

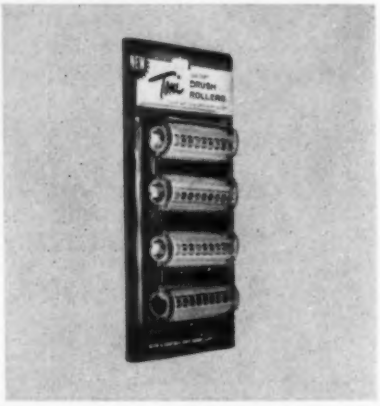
Triple Protection Lindy found that skin packs using Campco Butyrate offered a number of other significant advantages. For example, the pack protects pens from dust and handling damage. The possibility of pilferage is reduced, too, since Campco Butyrate is very difficult to tear or puncture. Campco Butyrate is also extremely "compatible." Packages using this material can't discolor products made of dissimilar plastic materials.

Campco Acetate adds buy appeal to caster cup display

Campco Acetate shows its ability to add eye- and buy-appeal to simple packaging jobs such as these caster cups, manufactured by Ajay Manufacturing Co., Kansas City, Missouri. In addition to making an attractive point-of-purchase display, it also protects the product, keeping it neat and clean, and helps to sell cups in convenient sets.

Crystal Clear Packages A special non-blushing formulation in Campco Acetate enables the material to maintain its crystal clarity—prevents clouding and discoloration. That's why these caster cups show up so well—and sell so well.

"Toni" Brush Rollers kept clean and sanitary with Campco Butyrate



An important consideration in packaging these brush rollers is that they be kept clean, sanitary and undamaged while on display. Campco Butyrate has proven to be an economical means of solving this problem—offering, in addition, the benefits of highly visible product display.

No Shattering or Cracking Campco Butyrate is extremely strong and pliable. It can be deep formed, patterned and hole punched without shattering or cracking. Available crystal clear and in a variety of colors—rolls and sheets in thicknesses .005" to .125"—stock or custom size. Package illustrated produced by Mankato Paper Box Co., Mankato, Minnesota.

Received Your Campco Packaging Data File? This data-packed reference file on thermo-plastic sheet and film is yours on request—just send name and address on Company letterhead to Campco, 2717 H Normandy Ave., Chicago 35, Illinois.

CAMPCO Sheet and Film, **a Division of Chicago Molded Products Corp.**

grow to 200 million lb. a year by 1970. Celcon is now in production at Clarkwood, Texas, in pilot plant quantities. A commercial plant is scheduled for completion in early 1962 at Bishop, Texas, where Celanese operates the largest single formaldehyde plant in the world.

More integration in vinyl chloride

The vinyl chloride industry has become more and more integrated almost every month, and there is certainly no indication that the trend has halted. Latest in the line of producer-customer type combinations was indicated in the announcement that The Borden Co. was negotiating for the acquisition of Columbus Coated Fabrics Corp. The latter company is one of the oldest and most notable quality houses in the vinyl fabric coating business and is one of the largest independent firms. Its assets have been listed at over $18 million. The company's reputation was established many years ago by the production of a high-quality oil-coated fabric wall covering. From that springboard the firm advanced into vinyl coating to become a leading factor in the industry.

Borden has now built, within a very few years, an impressive structure in various areas of plastics, going far beyond its original position in adhesives that was established originally in casein before World War II.

The firm has a 40-million-lb. PVC plant in Leominster, Mass.; is building a new 40-million-lb. PVC plant in Illiopolis, Ill.; operates a vinyl extrusion plant in North Andover, Mass.; another extrusion plant in Compton, Calif. (formerly Resin Industries); has combined with U. S. Rubber (as Monochem Inc.) to build a $50-million chemical complex in Louisiana for annual production of 80 million lb. of acetylene and 150 million lb. of vinyl chloride monomer; is a major producer of vinyl acetate, and is increasing its facilities to produce polyvinyl alcohol with a very special resin that can be used for dissolvable film.

Is this integration or expansion?

Another important move in the vinyl chloride industry was the acquisition of Landers Corp., Toledo, Ohio, by International Printing Ink, some months ago. IPI was already operating Kotan in Newark, N. J., where similar products are produced. IPI will continue to operate both companies in their present locations, but under its Coated Fabrics Div. in New York. Kotan, like Columbus Coated, also gained an early reputation for the excellence of its oil-coated wall covering and then went into vinyl coating. Landers' greatest output went to the automotive industry, Kotan's to furniture. The two together give IPI an excellent combination of marketing outlets. IPI also owns Wadsworth & Woodman, Winthrop, Me., another coater of light-weight goods. IPI once owned Standard Coated Products of Buchanan, N. Y., but sold out about six years ago.

The combination helps to consolidate the vinyl chloride industry into a smaller number of management groups. But it is different from the prevailing producer-processor integration. IPI does not produce resin, although it does manufacture pigments, color dispersions, vinyl inks, and plastisol foam.

Still another type of integration is the Dow Chemical Co. notice that it will manufacture rigid containers and blown ware in its Findlay, Ohio, plant using processes developed by Dow and processes licensed by the Illinois Tool Works. The blown ware equipment was made by Hoover **(To page 45)**

where quality is a matter of life or death

In the manufacture of medical tubing there is no margin for error . . . human lives hang in the balance. That is why manufacturers of medical tubing and apparatus have adopted VYGEN 120 . . . the quality PVC resin that satisfies the rigid government specifications. VYGEN 120 is not just another quality resin, but one of a family of specialized resins developed and manufactured to meet the requirements of the processor and the demands of the end product. No matter what your processing requirement, you should look to the VYGEN family of PVC resins just right for every application. For complete information call or write us today!

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VYGEN 85 — Recommended for calendering, extrusion and molding operations where processing at low temperatures is desired.

VYGEN 105 — For light-embossed sheeting and for molded items and extrusions requiring high gloss finish.

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Ball & Bearing Co. of Ann Arbor, Mich. Grant W. Cheney is project director, and Corliss F. Cummins is marketing director.

Foaming agent for expandable vinyl chloride

Du Pont is now strenuously promoting a foaming agent for vinyl chloride plastisols, called Nitrosan (in years past it has been called BL-353). The reason for increased activity is the great market that has developed for foamed vinyl as a replacement for leather in jackets, upholstery, pocket books, shoes, luggage, wall coverings, etc.

Nitrosan is used primarily for foaming or expanding plastisols in a casting operation. It is not suitable in calendering but it can be used in molding plastisols. The advantage of Nitrosan is said to be that it decomposes (gives off gas) at a much lower temperature than the more commonly used blowing agents used in calendering. The latter start to decompose at temperatures of from 230 to 390° F. Nitrosan decomposes at 212° F., or before the plastisol starts to gel —which is at about 220° F. Furthermore, it gives an open-cell formulation which is claimed to be more resilient and have greater dimensional stability than the closed-cell type which is developed from other blowing agents. It foams before any gas is trapped within the formulation. The complete operation consists of casting a vinyl film on release paper, passing it through a reverse roll coater a second time to receive the expandable plastisol which contains Nitrosan, "kissing" it with a knit goods fabric for backing and then passing through an oven to foam the expandable plastisol and fuse the materials together.

Base coat for untreated polyolefin surfaces

A base coat that can be used on treated or untreated polyolefins, particularly polypropylene, before vacuum metallizing is now being offered by Flexabar Corp., Rockleigh, N. J. Ordinarily it is necessary to flame- or acid-treat the material to make sure the coating will stick. This same base coating, which is said to adhere with a "tenacious fierceness," may also be used for styrene type resins, Implex, urea, phenolics, and butyrate where it has been effective against outgassing. Since it can be used on most any plastic this coating obviates the necessity of storing various coatings for each type of plastic. The company is also developing a tough top coat with a hard surface that won't scratch easily.

In addition to the metallizing base coat, Flexabar offers a line of silk screen inks, paint and spray formulation for both the treated and untreated polyolefin surfaces, all of which are notable for adherence. On polypropylene fabric, the company's silk screen inks have withstood dry cleaning and washing cycles. The company suggests that use of coated color on natural polymers is less costly than molding with integrally colored resins and also makes available a wider range of hues. The same coating in a clear formulation is also reported to be useful as a vapor transmission barrier.

Polystyrene tumblers by the million

The high position of polystyrene in today's plastics world may have surprised some observers but almost nothing will ever happen again to surprise the producers— there have been so many surprises that new ones scarcely create the flicker of an

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...because TITANOX-RA-40 is rutile titanium dioxide especially suited to the pigmentation of modern vinyl tile compositions. At economically low loadings, it yields whites and tints that meet the most exacting standards of the industry.

In many plastic compositions, this new pigment produces high rutile opacity plus clarity of tints comparable to anatase. And TITANOX-RA-40 has the uniformity of all properties and ease of dispersion for which TITANOX pigments have long been noted throughout many industries. Titanium Pigment Corporation, 111 Broadway, New York 6, N. Y.; offices and warehouses in principal cities. In Canada: Canadian Titanium Pigments, Ltd., Montreal.

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eyelash. An example is tumblers. If all glass were to disappear there would be no need to worry about tumblers or drinking glasses—polystyrene alone could fill the void. Millions of pounds of general-purpose polystyrene have gone to market in tumbler form within the last few years. But the newest one on the market may outsell them all. It is coined-cut with heavy walls up to about 0.375 in. thick and clear as crystal. It can be thrown against a wall or bounced off the floor and will withstand the perils of going through a mechanical dishwasher. Loma Industries of Fort Worth, Texas, manufactures the tumblers from resin which they say is used directly from the container without any additive or compounding. The resin is a crystal, high heat-resistant polystyrene furnished by Foster Grant of Leominster, Mass. It is a high molecular weight resin that gives better flexural and tensile strength than normal resin, and additional strength is obtained by molding it in cylindrical form.

Melamine dinnerware sales to increase

A report in this column in the February issue which stated that the Melamine Council had been discontinued was inaccurate. The Council is still functioning, but out of new headquarters at 75 West St., New York, N. Y. Marcia Moore continues as the Council's stylist and is keeping up her visits to department stores for demonstration purposes.

The Council states that melamine dinnerware will rise another 10.9% this year on top of a 13.1% increase in 1960; that 150 million dishes were sold in 1960; and that the best-selling price line was $27.50, but that there was a large increase of $19.95 goods. Patterned dinnerware rose to 80.4% of total volume in 1960.

Is market research essential?

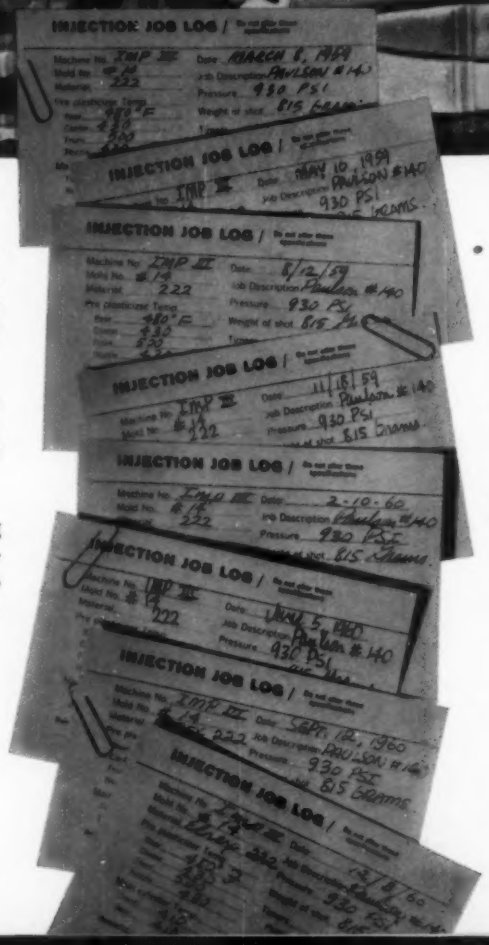
A recent meeting of the Chemical Market Research Association brought out some sharp comment on the relationship between market research and management as it pertains to forecasting and planning. Plastics in particular seems to be one of the areas that draws particular attention in this field. It is disturbing to realize that most market researchers have been generally predicting for the last three years the present discrepancy between sales and capacity and the consequent price drop in thermoplastics, yet their warnings were apparently disregarded. Perhaps their management was overruled by opinions of bankers who were more awed by the then current cost-profit spread than by the future supply-demand situation. And of course management is also inclined to "take-off" on an expansion binge when it feels the hot breath of competitors at its heels, regardless of what the researchers may say. There is no doubt that plastics is in for a long-term growth period, but the band wagon has run out far ahead of the parade and some of the wagons in the parade are going to get lost before they catch up.

Incidentally a side-line to the market researcher angle, to help point up their astuteness, was the statement made at the Pittsburgh meeting in 1956 that there would never be another automobile production year to equal 1955, until 1962 or 1963.

For additional and more detailed news see Section 2, starting on p. 200

what's your toughest molding requirement — uniformity?

for lot to lot, year-in, year-out dependability, specify Brand Elrex polystyrene.



Few polystyrene injection moldings call for such careful attention to mold conditions as large-shot retail display fixtures. To meet these high standards — without expensive set-up delays and wasted cycles — your resin must always be the same, each time it's dumped into your hoppers.

For Paulson Company's large-size sweater display case, Victory Plastics, Hudson, Mass., has used Rexall polystyrene crystal for over two years — without deviation from their original carefully determined mold conditions.

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Properties	Unit	*Elrex* 100 Series	*Elrex* 200 Series	Test Method ASTM
Tensile Strength	psi	6800-7800	6500-7500	D-638
Elongation	%	1.5-3.0	1.0-2.5	D-638
Tensile Modulus	psi	450,000-480,000	470,000-500,000	D-638
Flexural Strength	psi	9000-12000	8000-11500	D-790
Izod Impact ½" x ½"	ft. lbs. per in. notch	.35-.50	.30-.45	D-256-56
Hardness	Rockwell "M"	70-80	70-80	D-785-51
Deflection Temperature Under Load	°F at 264 psi fiber stress	175-182	170-178	D-648-56
Thermal Expansion	in./in.	.0003-.0004	.0003-.0004	D-696-44
Specific Gravity	—	1.05	1.06	D-792-50

The above data represent average laboratory values by the methods indicated and should be so considered. Since processing variables contribute heavily to product performance, this information should serve only as a guide. To the best of our knowledge, the data are accurate.

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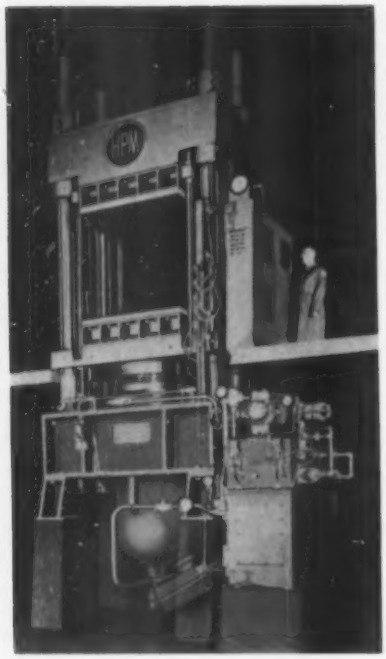
NEW MACHINERY-EQUIPMENT

Specifications, claims made, and prices appearing in these pages are those of the manufacturers or sellers of the machinery and equipment described, or their agents.*



HPM compression press is designed for pit location of hydraulic system.

Compression press

Currently in use in the molding of aircraft and missile components, this upward-acting 1000-ton press has a 60-in. clamp stroke with an adjustable daylight opening between platen and head of 90 to 120 inches. Maximum mold space is 48 in. square. The press has a closing speed of 300 in./min., and an adjustable pressing speed of 2 to 11 in./min.; opening speed is 54 inches per minute. Two sectional-type grids, or bolsters, 12 in. high, one mounted on the press head and the other on the platen, provide the necessary space for operating knock-outs. Upper and lower mechanical ejectors have a 6-in. stroke and are operated by the return of the press platen. A breathing, or degassing, cycle with timed pressure dwell is provided for in the equipment. *The Hydraulic Press Mfg. Co., Div. of Koehring Co., Mount Gilead, Ohio.*

Blow molder with ram accumulator

Designated Model 1412S-5, this single-station blow molder has a clamp force of 5 tons with fast platen closing under low pressure prior to final closing. High pressure is exerted on the last ⅛ in. of platen travel. Mold clamping area is 14 in. wide by 12 in. high. Longer molds can be used by extending above and/or below the platens. Daylight opening is 6 to 20 in., and platens are hydraulically actuated. Molded parts up to 9-in. diam. can be made. Dry cycle time is 3 sec.; actual cycles are dependent on the mold-cooling and ejection system. Press has a 16-oz. accumulator which allows rapid parison extrusions, with shot size easily set by a knob control. The blowing unit is designed for use with a Hartig 2½-in. extruder with a 20:1 L/D ratio. Standard package unit includes water-cooled screw, barrel cooling, clamp with yoke and cam lift, separate control panels for extruder and blow molder, and auxiliary supply hopper. *Waldron-Hartig Div., Midland-Ross Corp., Box 791, New Brunswick, N. J.*

Three-roll mill

These compounding machines have been equipped with gages to record roll pressure and thermostatically controlled water inlet valves which provide more precise control over adjustment of roll spacing and roll temperatures. The new controls, which are available on all mills ranging in size from 4½ by 10 to 16 by 40 in. (size of rolls), help avoid uneven wear on the rolls, allow the accurate resetting of roll spacings, and insure more uniform compounding results from batch to batch. The temperature controls permit limiting the roll temperatures to a preset temperature between 40 and 180° F. *Charles Ross & Son Co., 148-156 Classon Ave., Brooklyn 5, N. Y.*

Heater tapes

Trademarked Hotfoil, these new heating devices consist of metallic foils sandwiched between either plastics film or glass cloth. The flat construction of the heating elements provides better and more uniform contact of the heat source with the object to be heated. The plastic encased tapes can be used in applications requiring temperatures up to 230° F. For applications requiring temperatures higher than this, the glass cloth-encased heating foils will operate up to temperatures of 842° F. Typical applications in the plastics industry for these heaters include mold heating and heating tanks of viscous resins. *M.E.I. Co. Ltd., Upper Villiers St., Wolverhampton, England.*

Die cutter

Known as the Trim-O-Matic, this hydraulic press cuts out multiple vacuum-formed parts from a single sheet in one complete, automatic operation. Platen area is 18 in. square. Cutting cycle is preset according to the thickness of the material being trimmed. Ram force is 16 tons. Unit has two start buttons, one on each side of the machine, requiring the use of both hands and thus keeping the operator's hands out of the immediate danger area. *Product Packaging Engineering, 5713 Joanne Place, Culver City, Calif.*

(More on page 52)

* Prices are deemed to be F.O.B. sellers' plants (unless otherwise stated), are for "standard" models, and are subject to change without notice. The publishers and editors of **Modern Plastics** do not warrant and do not assume any responsibility whatsoever for the correctness of the same or otherwise.

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meet all our molding requirements . . . About 2½ years ago we ordered our first Van Dorns. Because they proved so dependable, we have repeatedly re-ordered and use Van Dorn machines exclusively."

says Mr. S. S. Berger, President
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First American is a leading producer of polyethylene artificial flowers sold nationwide. To assist in their dynamic growth, they use only Van Dorn molding machines since their own experience has shown Van Dorns to be fast and economical. The presses are usually operated 24 hours per day, 6 days per week. They have all models—2½ oz., 3 oz., and 4 oz.—using a size best suited to each molding requirement.

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NEW MACHINERY-EQUIPMENT

(From page 50)

Foam molder

Designated Model EX-2, this system for the molding of expandable polystyrene beads is supplied complete with all necessary equipment. Included are a vertical-acting press equipped for automatic mold filling, operating controls, hot-air pre-expander and bead storage bin, Turbo-Boiler steam generator with accumulator, vacuum pump, air compressor with tank, and all valving, wiring, and piping. Because hot air, rather than steam, is used for pre-expansion the need to dry the expanded beads is eliminated and they may be fed directly from the pre-expander storage bin to the mold. Feeding is accomplished by pulling a vacuum on the mold; beads are blown up to the mold with compressed air. Also novel is the compact gas-fired boiler with an output of 240,000 B.t.u. This is supplied with each system, eliminating the need for a central steam supply. Additional specifications will be found in the table. Price for complete system is about $16,500. *Expandex Corp., Wauregan, Conn.*

Specifications: Expandex Model EX-2 foam molder (photo below)

Hydraulic press clamp force, tons	10 to 50
Platen size, in.	48 by 48
Mold space, in.	49 by 50
Mold daylight, in.	5½ to 35
Timer ranges, sec.	
Mold filling	0 to 150
Steam, drain open	0 to 60
Dwell	0 to 60
Cool	0 to 150
Pre-expander capacity, lb./hr.[a]	60
Expanded bead storage capacity, cu. ft.	72
Boiler efficiency, %	80
Boiler accumulator capacity, cu. ft.	15
Compressor air supply, cu. ft./min.[b]	7.5

[a]Maximum rate of 2 ±¼ lb. cu. ft. density dry beads. [b]At 100 psig. with 2 hp. motor. Compressor is air-cooled single stage unit.

Color meter

Called the Colormaster Differential Colorimeter, this instrument can be used for color matching plastic samples and for plastics color quality-control work. The instrument has an adjustable zero attachment for standardizing the instrument. Color readings are given in terms of green, red, and blue reflectance values, or *X*, *Y*, and *Z*. Rapid computations of reflectance values into Adams Coordinates —*L*, *a* and *b*—may be readily made with charts or an auxiliary computer unit. *Manufacturers Engineering & Equipment Corp., York and Sunset Lane, Hatboro, Pa.*

Gel timer

The Mol-Rez gel timer is designed to measure the time that it takes thermosetting resins to gel or cure. It can be used with polyesters, epoxies, polyurethanes, ureas, melamines, and phenolics. In operation, a catalyzed sample of resin is placed in contact with a disposable moving element of the timer, which can then be left unattended. When the resin sets, or gels, an indicator light goes on and the timer automatically stops at the time of gelling, recording the time to the nearest minute. The disposable sensing element in the gelled sample may be discarded, since its cost is negligible. Unit is priced under $100. *Mol-Rez Div., American Petrochemical Corp., 3134 California St., N. E., Minneapolis 18, Minn.*

Mold chiller

Designed for mold-cooling applications requiring sub-freezing cooling liquid temperatures, the IMS 2 hp. mold chiller will handle anti-freeze solutions using alcohol-type fluids. Unit has a ¼-hp. circulating pump rated at 20 gal./min. against a 23-ft. head. Also included is a 4-in. diam. dial thermometer with a range of 0° to 200° F., as well as an adjustable thermostat control. Cooling fluid tank capacity is about 15 gal. and the unit is rated at 18,850 B.t.u. Price of the unit is $1595. *Injection Molders Supply Co. Inc., 17601 S. Miles Rd., Cleveland 28, Ohio.*

Parts service

Under a rapid, guaranteed Platen and Link Replacement Package Plan, precision-rebuilt platens for 8-, 10-, and 12-oz. Reed-Prentice injection machines, completely assembled with links and new parts, are shipped from stock on an approval basis within 48 hr. after the order is received. *Adco Engineering & Mfg. Co. Inc., 2133 Lincoln Ave., Chicago 14, Ill.*

Heat sealer

The air-operated P20 press (above) is designed specifically for the electronic welding of plastics in conjunction with Thermatron heat sealing generators ranging from 3 to 10 kw. of output. Built with a "C" frame of cast iron, the press has a 7-in. stroke (less die height) and 6½ in. of daylight between the die mounting plate and press bed. Throat clearance is 10 inches. Press is powered by a 3½-in. diam. air cylinder which delivers 1200 lb. force using a 125-p s.i. air supply. A 6-in. diam. cylinder is available at extra cost. The 20 by 30 in. annealed-surface, ground-steel bed plate is twice as stiff as cast iron and is a convenient 36 in. above floor level. Press movement rides on machined "V" ways. *Thermatron Electronics Div. of Willcox & Gibbs Sewing Machine Co., 214 W. 39th St., New York 18, N. Y.*

Hopper loaders

Four different models of vacuum loading systems have been added to the Rainco line. One is a flake loader suitable for loading fluffy or flaky materials which usually exhibit poor flow characteristics. Second is a standard model capable of loading up to 1200 lb./hr. of standard pelletized material. Third is a similar model with a capacity up to 1800 lb./hr. Also included in the line is a dust-tight model suitable for loading powdered materials and very dusty dry-color material blends. *Rainville Co. Inc., 839 Stewart Ave., Garden City, N. Y.*

(More on page 54)

MORE

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HIGH TORQUE EXTRUDERS

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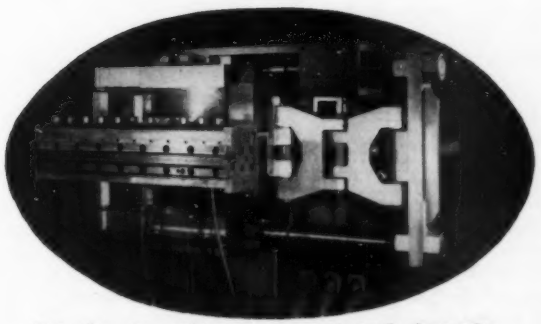

Photo above shows quick-opening pneumatic toggle clamp gate.

Polypropylene demands higher torque and more horsepower per pound than most other polymers. These requirements are amply met by the PRODEX 8" High Torque EXTRUDER, with an L/D ratio of 24:1. It compounds polypropylene directly from powder feed. Motor drives up to 500 horsepower are being used with these extruders.

Special features incorporated in these machines include devolatilizing sections and built-in vacuum systems for efficient removal of volatiles, also quick-opening pneumatic toggle clamp gates to permit fast screen changes without use of tools.

Complete trains for cooling and pelletizing the product are available. Explosion-proof extruders for hazardous atmospheres can be supplied.

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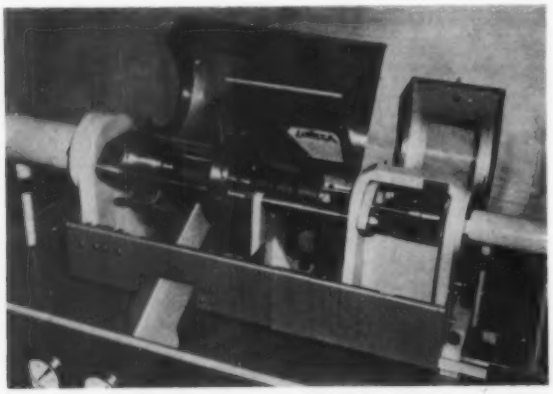
ALWAYS A YEAR AHEAD

NEW MACHINERY-EQUIPMENT

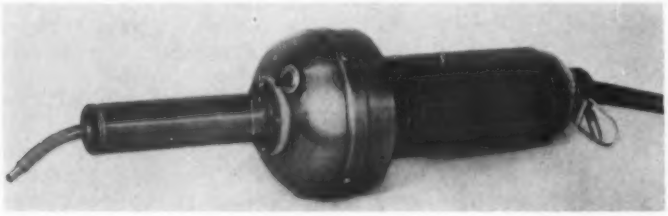
(From page 52)



Small injection machine for fast operation

The Model LA-10 machine is designed for the production of small plastic parts. It has a nominal shot capacity of 0.35 oz. and will plasticate styrene at the rate of 20 lb. per hour. Specified output is 25 shots per minute. Injection pressure is rated at 14,228 p.s.i., which allows parts with wall thickness as thin as 0.016 inches. Projected mold area is 8 sq. in. and the mold platen is 4 in. square. Minimum mold thickness is 4 in. and mold opening space is 5⅛ inches. Heaters draw 2 kilowatts. Mold clamping force is rated at 12 tons. The unit is equipped with a Vickers hydraulic unit with a special oil cooler. Floor space is 1 ft. 8 in. by 5 ft. 4 in. and height is 5 feet. *Society Lumeca, 33 Rue Jonquoy, Paris XIV°, France. Sole agents are Ed. Regamey & Cie, 104 Rue Haxo, Paris.*

Welding tool requires only single electrical connection



The Model LKS electro-hot air welding tool is designed for use with most thermoplastics. The hot-air welding torch is completely self-contained, and has its own electrically driven air blower to provide a stream of welding air. No outside air supply is needed. Integral heating elements raise the air to welding temperatures between 350 and 1000° F. The unit plugs into any ordinary wall outlet, will operate on AC/DC power supplies of 220, 110, and 42 v., and is supplied with a 10-ft. cord and two special air jets made of stainless steel. Price complete is $98 F.O.B. mfr. *Weldotron Corp., 841 Frelinghuysen Ave., Newark 12, N. J.*

High-speed wire coater and spiral striper

The Andouart Helicolor Wire Coating machine is a complete processing unit which insulates wires with helical striped material in up to three colors, using such materials as PVC, polyethylene, nylon, and other thermoplastic materials. The unit is made up of three basic sections: a wire payoff section which handles the bare wire feed, a center section of three extruders feeding the coating crosshead, and a take-up section where the coated wire is taken up and spooled. The spiral striping effect is achieved by rotating the wire on its axis as it moves through the cross-head. Because of the special design of the wire-feeding and spool-up sections, it is possible to coat either stranded or solid wires from 0.016 to 0.039 in. in diameter at spool speeds up to 5000 r.p.m. Minimum helical striping lead is 0.158 inch. *Thermoplastic Equipment Corp., Valley Rd., Stirling, N. J.*

Bulk truck

For plastics processors with bulk handling facilities, this tank truck is designed for plant-to-plant or siding-to-plant transfers of granular and powdered materials. Complete with its own pneumatic system, the truck can load polyethylene pellets into itself from hopper cars at the rate of 20 tons/hr. and, after transporting them to the plant, can unload into the material storage silos at a rate of about 30 tons/hr. To prove the truck's ability also to handle vinyl powders, one user loaded the truck about 100 mi. from its plant; drove it to the plant; and left the load standing outdoors for 1 week before unloading. It was then unloaded without difficulty or apparent moisture pickup at the rate of 500 lb./min., conveying the powder to in-plant storage situated 80 ft. vertically and 80 ft. horizontally from the truck. The truck is self-cleaning and the pressurized system permits switching from one product to another without apparent contamination. *Sprout, Waldron & Co., 130 Logan St., Muncy, Pa.*

Wire and tubing marker

Using special marking foil, an electronic dwell timer, and an adjustable air pressure-driven stamping head, the KW-7 hot stamp wire marking machine will continuously mark Teflon and other plastic-coated wires and tubing at rates over 170 stampings per minute. Close control of the operation allows the marking of thinly coated wires without impairment of dielectric loss properties. Control of the stamping temperature is facilitated by a visual temperature indicator which is calibrated in both temperature scales up to 500° F. and 260° C. A lightweight pulling wheel with Neoprene "O" rings reduces torque loads on all moving parts and eliminates the bothersome problem of improper spacing of the markings. *Kingsley Machine Co., 850 Cahuenga Blvd., Hollywood 38, Calif.*

Extruder

Included as standard equipment, this 2½-in. extruder has an Xaloy-lined barrel, screw and barrel with an L/D ratio of 20:1, resistance band heaters, and a variable screw-speed control system. Offered as optional equipment for the 2½ in. model are a barrel and screw with a 24:1 L/D ratio, a circulating oil pump, air or water cooling systems, metering valves, pressure gages, and melt thermocouples. *Killion Tool & Mfg. Co., 58 Depot St., Verona, N. J.*

(More on page 56)

—the revolutionary

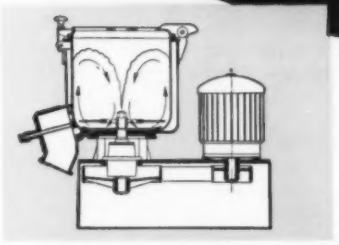
PRODEX-HENSCHEL MIXER

U.S. Pat. No. 2-945,634

for INTENSIVE

- ✓ Resin Dryblending
- ✓ Pigment Dispersion
- ✓ Mechanical Heating

of resins and compounds in EXTREMELY SHORT CYCLES WITH EXCELLENT UNIFORMITY!



In the **PRODEX-HENSCHEL MIXER,** a specially designed propeller-like impeller rotates at peripheral speeds of about 150 ft/second. The centrifugal action of this impeller creates a rapid and continuous flow of the mixer charge through the impeller blades. The high impact velocity of the blades and their shearing action break down agglomerates and cause intimate dispersion of all ingredients. The impeller is designed for large energy transfer to the mixer charge so that rapid mechanical heating is also obtainable. The heating rate is controlled by selection of the proper speed on the multiple speed motor drive. Mixing cycles for complete dispersion are usually so short that heat build-up is negligible where it is not desired. The mixers are jacketed for heating or cooling, and a stock temperature indicator is provided for continuous observation of the batch temperature.

Hundreds of PRODEX-HENSCHEL MIXERS are being successfully used for...

- ✓ Plasticized Vinyl Dryblending
- ✓ Rigid PVC Dryblending
- ✓ Pigment Dispersion in Polymers
- ✓ Acetate and Butyrate Dryblending
- ✓ Filler Mixing with Thermosets
- ✓ Fibre Mixing with Polyesters
- ✓ Dry Coloring

PRODEX-HENSCHEL MIXERS ARE AVAILABLE IN FOUR SIZES

MODEL	2JSS	18JSS	35JSS	115JSS
TOTAL CAPACITY (cu. ft.)	0.37	2.7	5.3	17.5
USEFUL CAPACITY (cu. ft.)	0.25	1.8	3.5	11.5
MOTOR H.P.	2	15	32	92

Also available in vacuum-tight construction for vacuum extraction with large material surface exposure and continuous agitation.

The **PRODEX-HENSCHEL MIXER** is cleaned in minutes, due to its smooth interior design. All contacting surfaces are made of stainless steel. It is easily loaded and discharged while running.

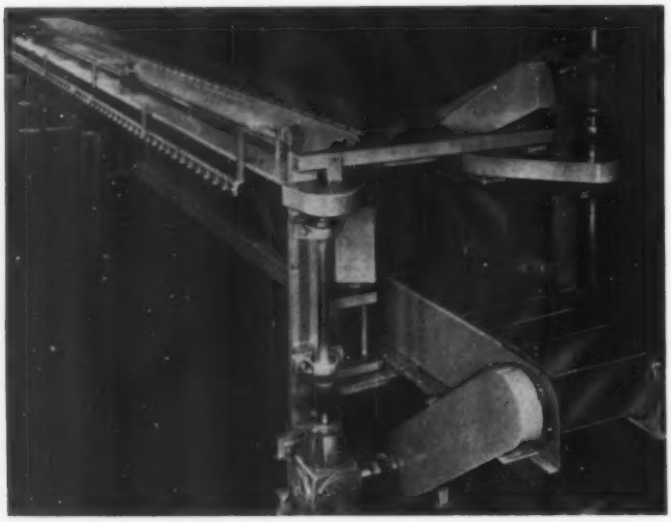
See the **PRODEX-HENSCHEL MIXER** perform with your material. Write or phone for an appointment.

Write for illustrated bulletin M-1.

PRODEX CORPORATION
FORDS, NEW JERSEY • Phone HILLCREST 2-2800

NEW MACHINERY-EQUIPMENT

(From page 54)

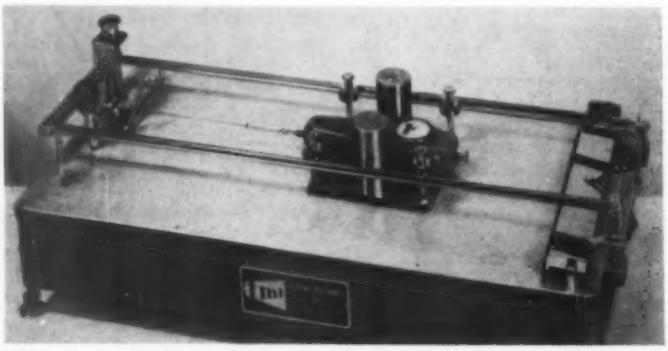


General-purpose take-off conveyor

Used as a take-off for an extruder or for the continuous foaming of plastics, such as rigid polyurethanes, this 4-sided "moving tunnel" is a combination of four synchronized stainless steel belt conveyors. The height of the rectangular cross section is adjusted by raising or lowering the top conveyor. Adjustable spring mounting of the top conveyor compensates for extruder or foam head output variations and permits control of the working pressure. Variable speed drives are available, with remote control and indication of speed optional, for precise speed control. All belts run on ball bearing rollers. Units are supplied in various sizes, metals, and designs. *M-H Standard Corp., 515 Communipaw Ave., Jersey City, N. J.*

Sheet and film static and sliding friction tester

Suitable for the determination of the slip characteristics of plastic films, the TMI Slip and Friction Tester is constructed with a constant-speed drive and dead-weight platen pressure system. The moving platen, which slides over the sample, has a force gage mounted on it. The gage registers the maximum force required to start the platen sliding or the starting friction. The force gage may also be converted to indicate continuously the force required for slippage over the entire test surface. Force readings can then be averaged to obtain the dynamic or sliding friction coefficients. The small sliding platen supplied can be used alone or attached to a larger platen to measure larger samples. Sixteen additional ½-lb. weights are included, which may be used by the customer to increase the instrument's range. *Testing Machines Inc., 72 Jericho Tpke., Mineola, N. Y.*



TMI slip and friction tester can be used to determine blocking characteristics of plastics sheets and films.

Heat sealer

Designated Model 300-SP20, this electronic heat sealer has been designed to minimize the cost of the unit without sacrificing its efficiency. Using a twin "V" ram construction, the machine has a bed plate 16 by 24 in., an upper plate 10 by 12 in., an exclusive floating control circuit, and a conveniently-located front control panel. Price of the heat sealer, F.O.B. manufacturer's plant, is $1495. *Sealomatic Electronics Corp., 38 West 32nd St., New York, N. Y.*

Mixer-blender

The Littleford-Lodige mixer is available in several sizes and models for both batch and continuous operation, and is suitable for the blending of dry granular materials, such as colorants and resins, and vinyl dry-blend formulations. Plough-shaped impellers hurl the materials to and fro within the mixing chamber and away from the walls. Because of the intensive mixing action, trace amounts of ingredients in proportions of 1 ppm. can be homogeneously dispersed in times ranging from 30 sec. to 8 minutes. Mixer can be used whenever the materials are capable of agitation in the dry state, and when liquids are added, even to the point of dough-like consistency, provided the mixing process is stopped when viscosity reaches this point. Sizes range from lab models with capacities of 1 gal. to production machines holding 170 cu. feet. Both unheated and jacketed models are available on request for specific applications. *Littleford Bros. Inc., 453 E. Pearl St., Cincinnati 2, Ohio.*

Extruder

This 3½-in. machine has an L/D ratio of 20:1 and an unusually high screw centerline located 60 in. above the floor level. The unit is supplied with either mica band heaters or cast aluminum heater units, as desired. Various screw designs and compression ratios are available. The barrels are provided with coil and blower cooling for frictional heat control. Extruder is delivered with all wiring complete, including proportional heat controllers. Also included are a continuous forced-filtered oil system, a water-jacketed feed throat, and a flexible coupling between the gear transmission and the thrust bearing to prevent thermal misalignment between these two machine components. *Olympia Tool & Machine Co., 119-121 Delancy St., Newark 5, N. J.*

(More on page 58)

P807-O/A

One of several very large Guinness Clock signs made from 'Perspex' acrylic sheet by The Electric Sign Company Limited, Marshalsea Road, London, S.E.1., for A. Guinness Son & Co. (Park Royal) Ltd.

'Perspex' shows Guinness time by day and night

THERE's no mistaking Guinness time when you see it on this huge sign–one of several made by The Electric Sign Company Limited. The whole sign including the letters and the clock face has been made from 'Perspex' acrylic sheet, to produce an attractive modern sign by day or, by internal illumination, a brilliant sign by night. 'Perspex' is a wonderfully versatile material for sign construction. It can be readily shaped and engraved. Mounting and inlaying present no problem. It can be easily shaped into letter forms and takes printing perfectly. And the smooth durable surface is easy to maintain and will stand up to bad weather conditions. For attractive signs that last, specify 'Perspex'.

'PERSPEX'

'Perspex' is the registered trade mark for the acrylic sheet manufactured by I.C.I.

ICI

Imperial Chemical Industries Ltd., Plastics Division, Export Dept., Bessemer Rd., Welwyn Garden City, Herts., England.

U.S.A. Enquiries to: J. B. Henriques Inc., 521 Fifth Avenue, New York 17, N.Y.

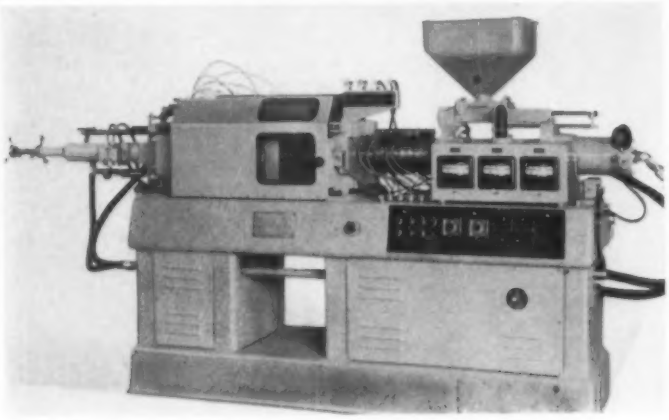
Canadian Enquiries to: Canadian Industries Limited, Plastics Division, P.O. Box 10, Montreal, P.Q.

NEW MACHINERY-EQUIPMENT (From page 56)

Continuous vacuum former for packaging applications

The Roll-Matic-Form is an automatic continuous vacuum former especially suited for the production of containers from thermoplastic sheet and laminates. It is equipped with a special conveyor system and performs the following operations: unwinding the coil feed, blocking, pre-heating, forming and cutting of the piece, part ejection, and winding of the scrap sheet. All operations are completely automatic. It is a one-station machine which will handle molds up to 10 in. square and will form pieces up to 5 in. deep. Maximum production speed of the machine is 900 dry cycles per hour. *A. Triulzi, Via Vialba 56, Milan, Italy.*

Injection presses with compact electrical system



MOSLO injection molding presses have all controls and temperature indicators conveniently located on the press.

This line of four Moslo machines are all designed with printed circuitry. Each model also has a transformer to provide 110-v. power for timers, controllers, and solenoid valves. Also standard in the line is hydraulic retraction of the injection section carriage. Model 1-12-85T has its movable and stationary platens bored to accept cartridge-type container molds. Each unit has two West Type JP temperature controllers, a pyrometer, and rheostat. All models have magnetic starters. Machines are modular in design. Further specifications are shown in the accompanying table. *Moslo Machinery Co., 2443 Prospect Ave., Cleveland 15, Ohio.*

Specifications: Moslo injection presses

	Model			
	1-12-85T[b]	*2-12-85T*	*2-12-85T*[b]	*3-12-85T*[b]
Shot size, oz.	1	2	2	3
Plasticating capacity, lb./hr.	80	60	60	60
Dry cycle rate, cycles/hr.[a]	1870 to 2170	1009 to 1188	1330 to 1478	1060 to 1113
Mold thickness, range, in.	5 to 12	5 to 12	5 to 12	5 to 12
Clamp force, tons	85	85	85	85
Maximum mold size, in.	10⅞ by 16	10⅞ by 16	10⅞ by 16	10⅞ by 16
Injection stroke, in.	3	4½	4½	6½
Injection pressure, p.s.i.	23,790	17,100	17,100	17,100
Injection rate, cu. in./min.	6.8	6.1	8.13	8.13

[a]Depends on whether a 6- or 12-in. clamp stroke is used. [b]High-speed model.

. . . Machinery in brief

▶ The 5 VA Varidrive variable speed drives have a new hand control and are available in speed ratios up to 10:1, from 4 to 10,000 r.p.m., in five sizes up to 1 hp., either three or single phase 60-cycle ac. *U. S. Electrical Motors Inc., P. O. Box 2058, Terminal Annex, Los Angeles 54, Calif.*

▶ The Electronik 17 series of instruments for process control employ a new type of balancing potentiometer device, which provides an infinitely continuous type of voltage variation and results in greater instrument accuracy. *Brown Instruments Div., Minneapolis-Honeywell Regulator Co., 2753 Fourth Ave., S., Minneapolis 8, Minn.*

▶ Called the Thermionik, this new heater power system for ovens uses thyratron electronic tubes in place of contactors or saturable core reactors. *Despatch Oven Co., 619 S.E. Eighth St., Minneapolis 14, Minn.*

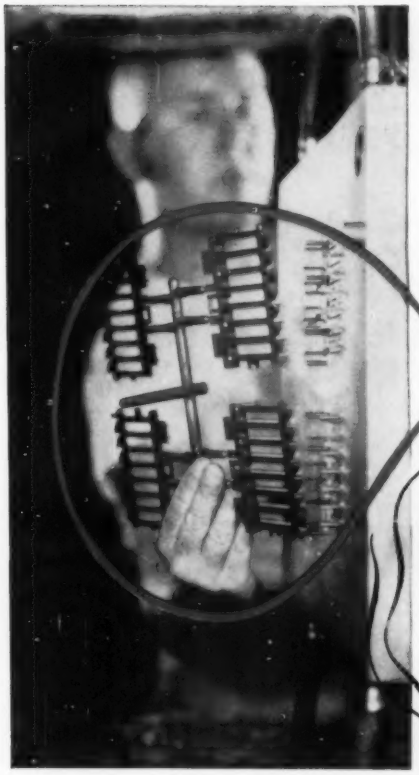
▶ Recommended where a heavy silicone mold release film is required, IMS Super 33 aerosol-packaged parting agent contains 33% pure silicone ingredients. Formulation is said to be non-toxic. *Injection Molders Supply Co. Inc., 17601 S. Miles Rd., Cleveland 28, Ohio.*

▶ For use in styrene foam molding and other plastic processes requiring steam, this new steam boiler has a novel design which provides for maximum water circulation over the fire tubes and greatly improved heat transfer and efficiency. *Orr & Sembower Inc., Reading, Pa.*

▶ Fifty cu.-ft. rotating vacuum dryers capable of reducing moisture in reground nylon from 2 to 0.02% are available as a complete "package" installation from the *F. J. Stokes Corp., 5500 Tabor Rd., Philadelphia 20, Pa.*

▶ Fast, easy, and efficient dispensing of many heated materials including thermoplastics, adhesives, and other compounds can be done with Sta-Warm dispensing tanks and pots. *Sta-Warm Electric Co., Ravenna, Ohio.*

▶ Lea Lint-Off No. 7527 is a solution which, when applied to plastic surfaces, neutralizes the static charge build-up which is a common cause of lint and dust accumulation on plastic parts. Lea Lint-Off may be applied by hand wiping or by direct transfer from a soft wipe-off buffing wheel. *The Lea Mfg. Co., 16 Cherry Ave., Waterbury 20, Conn.*—**End**



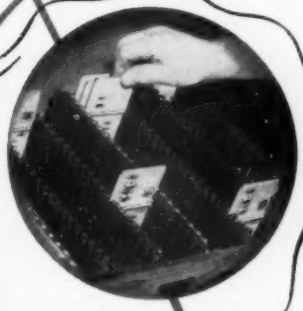
Thermoplastic card guides for IBM 1401 processing unit, ejecting from precision molding dies at Quinn-Berry Corporation, Erie, Pa.

NERVE CENTER OF

"Electronic Mathematician"

protected by . . .

PRECISION CARD GUIDES



Printed circuit cards shown above inserted in molded card guides which prevent cards touching each other, help steady cards during shipment and protect cards during thermal changes.

Fully assembled IBM 1401 processing unit, nerve center of IBM 1401 data processing systems.

Molded of LEXAN® Thermoplastic

by Quinn Berry

In the IBM 1401 processing unit, nerve center of IBM 1401 data processing systems, it is of paramount importance that Card Guides help maintain card position during movement and thermal changes.

Quinn-Berry's skilled precision mold design and engineering teams up with experienced press room operation to meet IBM close tolerance specifications. Skilled craftsmen mold IBM Card Guides of Lexan® polycarbonate resin, a product of General Electric Plastics Division, to meet the most rigorous requirements. The result—parts which have excellent dimensional stability, extreme resistance to impact and which are self extinguishing.

Your requirements for precision molded thermoplastic parts can be fully satisfied at Quinn-Berry—place them with us in full confidence. Here, the Unusual is Routine.

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Phone: Ludlow 600-80

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CUSTOM MOLDERS OF ALL TYPES OF THERMOPLASTICS

WORLD-WIDE PLASTICS DIGEST*

Abstracts from the world's literature relative to plastics. For complete articles, send requests directly to publishers. List of addresses is at end of this section.

General

"Tritactic" polymers are optically active. Chem. Eng. News *39*, 44-45 (Jan. 16, 1961). Asymmetric polymerization of certain symmetrical monomers, such as 1,3-butadiene, produces optically active polymers.

Materials

Fiber resin preform molding. A. Lewin. Plastics Inst. Trans. *28*, 224-32 (Dec. 1960). Pulp preforms are used with phenolic resins to mold plastics items. The various techniques are described in detail.

Organotin compounds. R. K. Ingham, S. D. Rosenberg, and H. Gilman. Chem. Rev. *60*, 459-539 (Oct. 1960). The synthesis, properties, and applications of organotin compounds are reviewed in detail. Applications of interest in plastics are as fungicides, polymerization catalysts, and stabilizers for polyvinyl chloride plastics. 924 references.

Thermooxidative degradation of polypropylene. Iu. A. Shliapnikov, V. B. Miller, M. B. Neiman, E. S. Torsueva, and B. A. Gromov. Vysokomolekuliarnye Soedineniia *2*, 1409-12 (Sept. 1960). A study was made of the thermooxidative degradation of polypropylene in the presence of some antioxidants. The most active of those studied (ionol, propylgallate, "Neozone D," and diphenyl- *p*-phenylenediamine) prolong the induction period of polypropylene oxidation by over 70 times at an antioxidant concentration 0.01 mole/kg. and a temperature of 140° C.

Molding and fabricating

Application of electrical insulation by the fluidized-bed process. M. M. Lee. Electro-Technology *66*, 149-53 (Oct. 1960). The advantages and limitations of the new fluidized-bed process for applying insulation to electrical and electronic components and equipments are given. Design parameters, economics, as well as practical applications for the process are explored and developed.

Structural bonding of polyolefins. R. G. Baker and A. T. Spencer. Ind. Eng. Chem. *52*, 1015-17 (Dec. 1960). A bonding technique is described for producing bonds between copper and polyolefins that are stronger than those produced by present commercial methods. Polyolefins are bonded to copper covered with a layer of cupric oxide at 400 p.s.i. and 204 to 288° C. As pointed out in this study, the higher temperatures require only a few minutes.

General design principles of rubber and plastics extruding machinery. E. Morris. Plastics Inst. Trans. *28*, 251-53 (Dec. 1960). The general design principles that are in effect for extrusion equipment are reviewed briefly and analyzed.

Die design in extrusion. P. L. Clegg. Plastics Inst. Trans. *28*, 245-50 (Dec. 1960). The relations among die design, the flow characteristics of the plastic, and the quality of the extrudate are considered.

Applications

Plastics in roofing—extrusion of corrugated PVC. Brit. Plastics *33*, 442-48 (Oct. 1960). Recent advances in extrusion of vinyl chloride plastics has focused attention on the potentiality of unplasticized PVC for roofing applications. Materials of this type are described and compared with acrylic plastic and polyester-glass compositions. New developments in England, Germany, and Japan are described.

Adhesive bonding of aluminum. E. D. Gardner and R. W. Flournoy. Adhesives Age *4*, 20-25 (Jan. 1961). Adhesives, design of joints, and techniques for bonding aluminum are described in detail. The adhesives used are based on synthetic rubbers, polyvinyl acetates, alkyd resins, phenolic resins, modified phenolic resins, and epoxy resins. A wide variety of bond properties is obtainable.

Properties

Optical and other electronic properties of polymers. I. Tinoco Jr., J. Chem. Phys. *33*, 1332-38 (Nov. 1960). A theory of optical activity in which the optical rotation of a molecule is related to the optical properties (polarizabilities) of groups in the molecule was previously derived. These relationships are treated again and include the previously neglected effect of static fields. The absorption coefficient, polarizability, optical rotation, dipole moment, and stability of a polymer are related to the properties at the individual groups in the polymer.

Flexural deformation temperature of amide-cured polyglycidyl and poly-2,3-epoxybutyl derivatives of phenol. D. Aelony. J. Appl. Polymer Sci. *4*, 141-50 (Sept.-Oct. 1960). The flexural strengths, flexural deformation temperatures, and Barcol hardnesses of epoxy plastics of various structures are reported.

Testing

Rapid identification of cellulose esters and ethers using paper chromatography. E. B. Mano and L. C. O. Cunha Lima. Analytical Chem. *32*, 1772-73 (Dec. 1960). A series of spot tests gives rapid qualitative analysis of cellulosic plastics. Cellulose esters are identified by saponification followed by paper chromatography of the acidic components. The simplified chromatographic procedure is completed in 2 hours. Only methyl- and hydroxyethylcellulose cannot be identified by these techniques.

Determination of thermal stability of vinyl chloride polymers and copolymers using the discoloration method. B. Schmitt and R. Breu. Kanststoffe *50*, 431-32 (Aug. 1960). The results of tests to determine the thermal stability of vinyl chloride resins by the discoloration method are reported and briefly reviewed.

Publishers' addresses

Adhesives Age: Palmerton Publishing Co. Inc., 101 W. 31st St., New York 1, N. Y.

Analytical Chemistry: American Chemical Society, 1155 Sixteenth St., N. W., Washington 6, D. C.

British Plastics: Iliffe & Sons Ltd., Dorset House, Stamford St., London SE1, England.

Chemical and Engineering News: American Chemical Society, 1155 Sixteenth St., N. W., Washington 6, D. C.

Chemical Reviews: American Chemical Society, 1155 Sixteenth St., N. W., Washington 6, D. C.

Electro-Technology: (Formerly Electrical Manufacturing): C-M Technical Publications Corp., 205 E. 42nd St., New York 17, N. Y.

Industrial and Engineering Chemistry: American Chemical Society, 1155 Sixteenth St., N. W., Washington 6, D. C.

Journal of Applied Polymer Science: Interscience Publishers Inc., 250 Fifth Ave., New York 1, N. Y.

Journal of Chemical Physics: American Institute of Physics, 57 E. 55th St., New York 22, N. Y.

Kunststoffe: Karl Hanser Verlag, Leonard-Eck-Str. 7, Munich 27, Germany.

Plastics Institute Transactions & Journal: The Plastics Institute, 6 Mandeville Pl., London W1, England.

Vysokomolekuliarnye Soedineniia: Academy of Science of U.S.S.R., Moscow, Russia.—**End**

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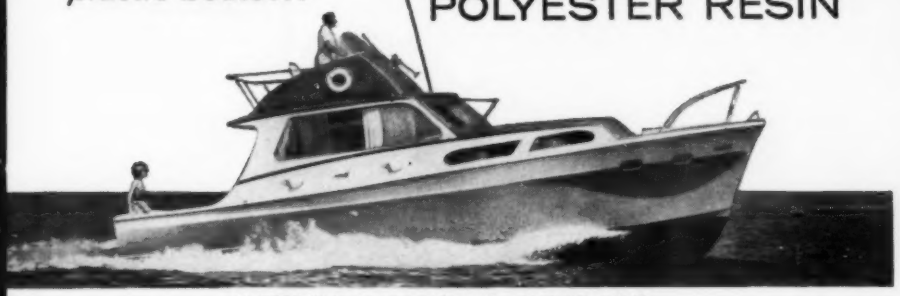


HATTERAS 41—Hatteras Yacht Co., High Point, N. C.

ARISTO-CRAFT FUNLINER "17"
Atlanta Boat Works Atlanta, Ga.

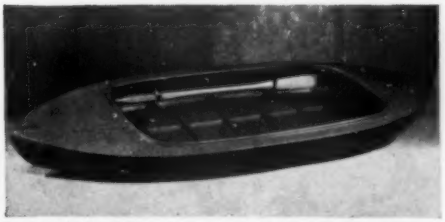
17' ESCAPADE—Shell Lake Boat Company
Shell Lake, Wisc.

RHODES 19—The O'Day Corporation
Boston, Mass.

13' BOSTON WHALER—The Fisher-Pierce Co.
Rockland, Mass.

17' IMPELLA—Volvo Powered
Sabre Craft Boat Co. Tacoma, Wash.

15' 7" MAG CAT—Magnolia Boat Co.
Vicksburg, Miss.



DUCK BOAT—Aluminum Boats & Canoes, Inc.
Princeville, P.Q., Can.

32' GILL-NET FISHERMAN
Ron Rawson, Inc. Seattle, Wash.

16' SEA QUEEN—Sea Fury, Inc.
Springfield, Mo.

17' REEFMASTER—Duratech Manufacturing Corp.
Peekskill, N. Y.

17' SEA LANCER
Flare Fiberglass Boat Co. Lakeland, Fla.

16' DEL MAR—Glasspar Co.
Santa Ana, Calif.

15' 5½" PIRATE—Span America Boat Company
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17' MARINE RAIDER—American Marc Inc.
Inglewood, Calif.

14' 5" MACKINAC—Wagemaker Boat Company
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RCI BUILDING, WHITE PLAINS, N.Y.

U.S. PLASTICS PATENTS

Copies of these patents are available from the U. S. Patent Office, Washington, D. C., at 25¢ each.

U.S. Pats., Dec. 20, 1960

Blown polycarbonates. G. Peilstocker and W. Hechelhammer (to Bayer). 2,964,794-7.

Hollow tubing. W. A. Schaich (to Owens-Illinois). 2,964,795.

Polytetrafluoroethylene hose. I. D. Press (to Resistoflex). 2,964,796.

Molded plastisols. W. Ferrell (to U. S. Rubber). 2,964,798.

Foam laminates. P. E. Roggi and R. A. Charter (to U. S. Rubber). 2,964,799.

Printing perfluorocarbon polymers. L. A. Kingsley (to Kingsley Stamping Machine). 2,964,867.

Polyurethanes. H. L. Elkin (to Thiokol). 2,965,584.

Porous polymers. J. A. Delap and R. E. Dietz (to Phillips). 2,965,585.

Epoxy resin compositions. W. Fisch, R. Hiltpold, and H. Batzer (to Ciba). 2,965,586.

Alkyd compositions. H. B. Rickert (to Dow). 2,965,587.

Alkyd compositions. F. R. Spencer (to American Cyanamid). 2,965,588.

Vinyl chloride resins. J. Dazzi (to Monsanto). 2,965,591.

Pressure-sensitive tapes. D. O. Ethier and R. A. Auger (to 3M). 2,965,592.

Organosiloxane polymers. T. J. Dietz. 2,965,593.

Polymers containing quaternary nitrogen. A. Maeder (to Ciba). 2,965,594.

Polytetrafluoroethylene. K. C. Brinker and M. I. Bro (to Du Pont). 2,965,595.

Polyvinyl chloride composition. G. H. Birum and T. M. Patrick Jr. (to Monsanto). 2,965,598.

Plasticizing linear polyamides. R. Gabler (to Inventa). 2,965,599.

Furfurylated phenolic resins. L. H. Brown (to Quaker Oats). 2,965,601.

Carboxy-copolymer epoxide compositions. D. D. Hicks (to Devoe & Raynolds). 2,965,602.

Polypropylene. F. P. Ford and J. R. Lovett (to Esso). 2,965,606.

Epoxide-substituted phenol polymers. R. W. Martin and C. E. Pannell (to Shell). 2,965,607-8-9-10-11.

Copolyesters. C. R. Milone, M. C. Shaffer, and F. S. Leutner (to Goodyear). 2,965,613.

Isocyanate homopolymers. V. E. Shashoua (to Du Pont). 2,965,614.

Polyurethanes. R. W. Tess (to Shell). 2,965,615.

Polyamides. J. R. Caldwell and R. Gilkey (to Eastman). 2,965,616.

Vinyl ester interpolymers. A. M. MacDonald (to Shawinigan). 2,965,617.

Crosslinking fluorinated elastomers. F. J. Honn and W. M. Sims (to 3M). 2,965,619.

Halogenating copolymers. G. E. Serniuk, D. L. Cottle, and T. Lemiszka (to Esso). 2,965,620-1.

Polyesters. C. E. Pannell (to Shell). 2,965,622.

U.S. Pats., Dec. 27, 1960

Extrusion. V. A. von Haase (to Von Machine). 2,965,926.

Injection molding. S. C. H. Smith (to R. H. Windsor). 2,965,929.

Polyepoxide solder. M. N. Paul (to Union Carbide). 2,965,930.

Polyvinyl chloride. W. J. Smythe, E. M. Muller, and R. W. Weeden (to Union Carbide). 2,966,469.

Plastisol. M. S. Maltenfort (to Chemedical). 2,966,470.

Polymer foam. H. D. Anspon (to General Aniline). 2,966,471.

Polyurethane. R. J. Fiel (to Allied Chemical). 2,966,472.

Polyoxymethylenes. R. D. Kralovec and P. N. Richardson (to Du Pont). 2,966,476.

Polyesters. R. F. Fischer (to Shell). 2,966,479.

Polymers of perfluorobutyne-2. A. N. Bolstad and F. J. Honn (to 3M). 2,966,482.

Cellulose esters. K. C. Laughlin, R. J. Osborne, and J. G. Santangelo (to Celanese). 2,966,485.

U.S. Pats., Jan. 3, 1961

Irradiation of nylon. E. J. Lawton (to General Electric). 2,967,137.

Epoxy-polyamide interpolymers. D. P. Hart (to Pittsburgh Plate Glass). 2,967,161.

Coating. J. A. Vasta (to Du Pont). 2,967,162.

Rain repellent. J. M. Fain and A. Goldman (to U. S.). 2,967,163.

Hydrocarbon-substituted polyethylenes. R. S. Aries. 2,967,164.

Copolymerization. G. C. Mustakas and E. L. Griffin Jr. (to U. S.). 2,967,166.

Polypropylene. P. E. Oberdorfer Jr. (to Sun Oil). 2,967,169.

Silicone compositions. G. H. Barnes Jr. and G. W. Schweitzer (to Dow Corning). 2,967,171.

Polymerizable acrylic esters. J. C. Fang (to Du Pont). 2,967,173.

Polyampholite. R. M. Summers (to Goodrich). 2,967,175.

U.S. Pats., Jan. 10, 1961

Hollow objects. F. Friedland, J. W. Sutton, J. Doggart, and D. F. Bartou (to V and E Plastics). 2,967,329.

Reinforced structures. B. D. Raffel (to Goodyear Aircraft). 2,967,796.

Phenolic resin. W. R. Moffitt and M. B. Berkey (to Borden). 2,967,836.

Curing epoxy resins. J. Greenfield (to Tung Research). 2,967,837.

Coating. R. L. Millar and C. G. Moore (to Glidden). 2,967,839.

Polyesters. B. Phillips and P. S. Starcher (to Union Carbide). 2,967,840.

Alkenyl aromatic resin. C. W. Roberts (to Dow). 2,967,842.

Epoxy resin. J. Delmonte and F. N. Hirosawa (to Furane Plastics). 2,967,843.

Resin-carbon black systems. W. L. Hawkins, V. L. Lanza, and F. H. Winslow (to Bell Telephone). 2,967,845-50.

Diol polyesters. J. A. Bungs (to Diamond Alkali). 2,967,854.

Copolymers. J. L. Lang (to Dow). 2,967,855.—**End**

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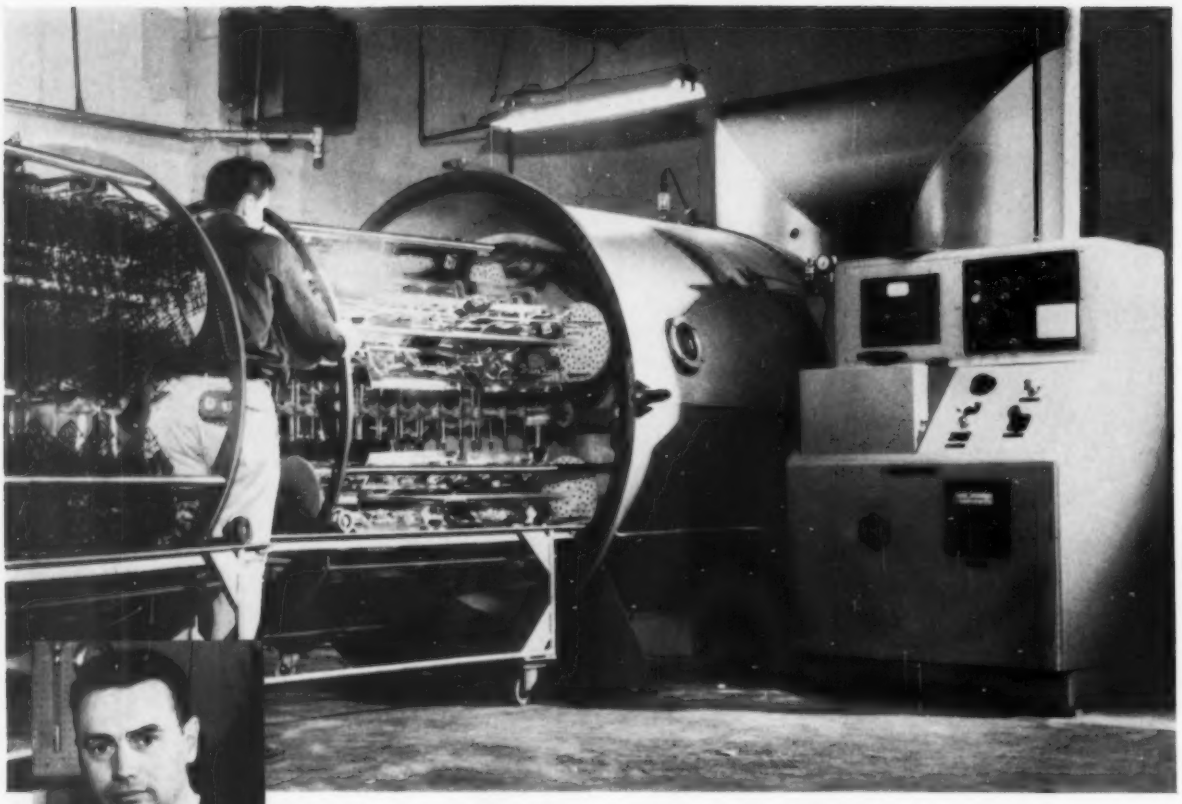

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PHILLIPS 66 MARLEX PLASTICS

BRIEFS

REPORT 61-2

Looking for new markets? Try us!

Although new items made from MARLEX are coming along fast and furiously these days, the market is hardly scratched. A big factor in this happy state of affairs is the ever-increasing number of potential uses for our resins because of constantly improving fabrication techniques and the development of more resin types.

Examples of MARLEX Marketing Information Reports available at our sales offices. To date, some 24 reports have been published.

Overabundance of potential applications has its problems, of course, for those fellows wishing to bring out new MARLEX items. What are the items with a ready market? What are the annual needs for these items . . . distribution . . . long range outlook . . . and so forth? Choosing new items is not easy when tooling and development dollars are involved. Perhaps our Market Research and Commercial Development Group can help when it comes to making these soul-searching decisions. They collect, tabulate, evaluate, and report on potential applications for MARLEX high density polyethylenes, ethylene copolymers, and tailored resins. As it is assembled, this marketing data is put in published reports that are available to all interested. They may be obtained at our district sales offices. If you're in the mood for new ventures . . . why not give us a try!

Thermoforming Shapes Up ...Yes, New Data

In the plastic industry, sheet-forming technology always seems to fall behind the availability of newly developed sheet. MARLEX High Density Polyethylene sheet is no exception. This is tough, durable plastic and forming it properly requires some extra "know-how." Yet, to those who have mastered the art, the outlook is exciting. Already such items are in the works as a 12-foot boat, decorative wall paneling, large re-usable shipping containers, lawn mower parts, and tote trays and boxes of all sizes and shapes.

We're doing our best to broadcast what we have learned from our research on thermoforming. In this vein, we have recently published some technical data on mold design. Discussed are such questions as mold material, cooling channels, contouring, surface finish, shrinkage, and male versus female molds. It's all contained in our Technical Information Bulletin No. 25, "Designing Thermoforming Molds for High Density Polyethylene." We also have a limited number of "MARLEX Sheet Weight and Cost Calculators," a useful slide-rule device for thermoformers. Write now!

Quality Control for Injection Molding

Assuming you're using resins of dependable uniformity and quality (such as MARLEX), there are a number of molding factors affecting the over-all quality and toughness of finished, high density polyethylene pieces. Most important are mold temperature, amount of mold packing, degree and uniformity of stock temperature, and injection speed. What are the effects of these factors? How can they be measured? What optimum values or conditions can be used to control quality during production?

We have just finished a rather exhaustive study on these questions . . . using a fair amount of technical paraphernalia. Interestingly enough, it all boiled down to some very simple and practical quality control measures. No expensive equipment is required . . . and superior molded pieces (often accompanied by appreciable resin savings) are the end results.

For example, both high production rates and maximum toughness are achieved with a low mold temperature. Mold temperatures above 100°F can result in poor quality items. Maintaining the minimum part weight consistent with good appearance is also important to both quality and economy. It is possible, through inadequate control, to pack as much as 17% excessive resin into a part. Brittleness and high part costs are the obvious results.

For those interested in a complete rundown on practical quality control while injection molding high density polyethylene and ethylene copolymers, we've put it all down in Technical Information Bulletin No. 27 . . . just off the presses.

The full scale thermoforming machine at our lab used in studying the problems of mold design. In the foreground, some of the items formed during this research program.

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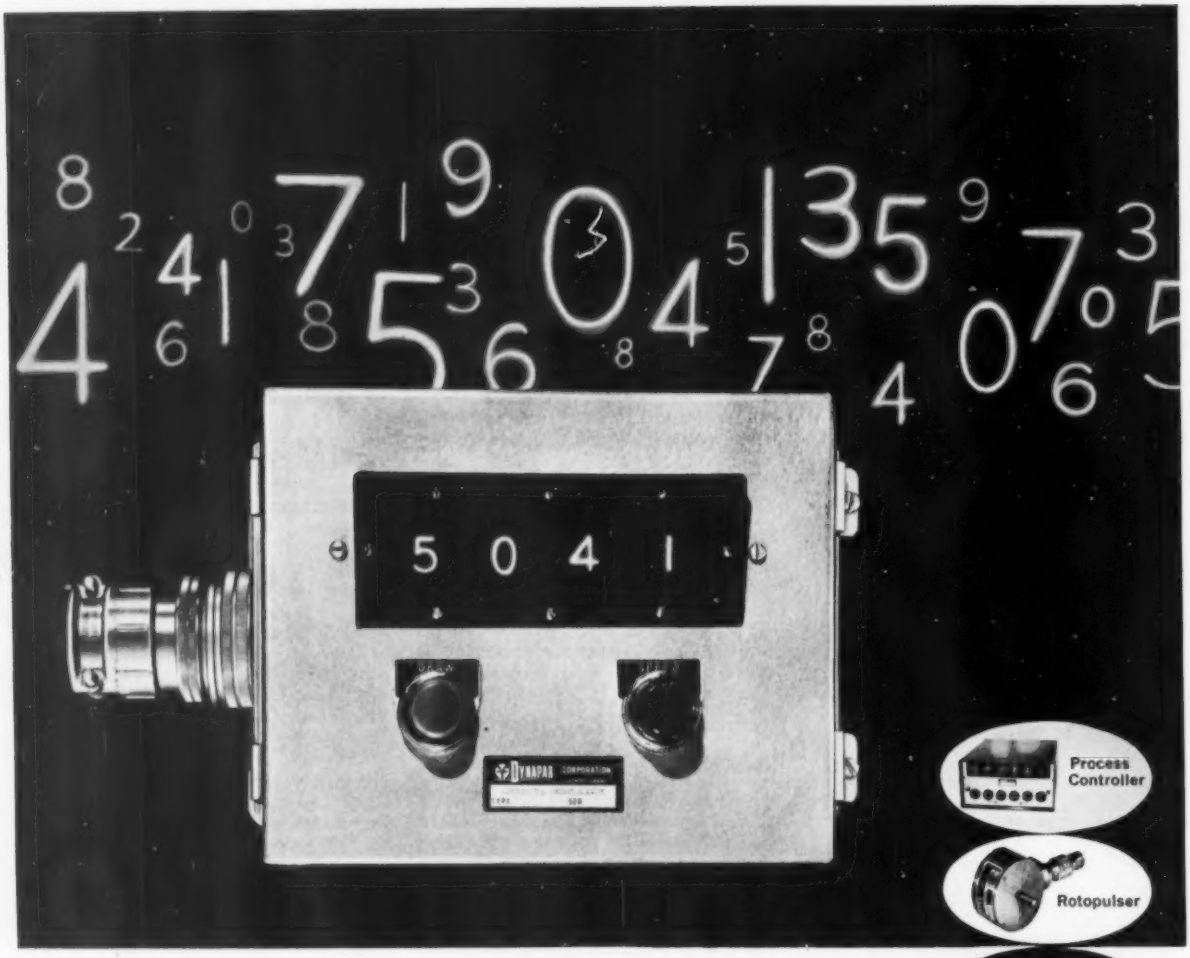

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Investigate to see how Louis Allis-Dynapar equipment can increase production and cut waste by automating *your* process. Call your local Louis Allis District Office, or write to The Louis Allis Co., 470 E. Stewart Street, Milwaukee 1, Wisconsin.

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Write for Bulletin PM-100. Address Dept. MP-461, National Rubber Machinery Company, 47 W. Exchange St., Akron 8, Ohio.

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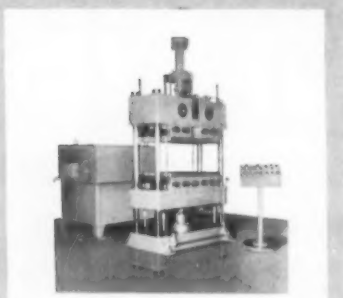
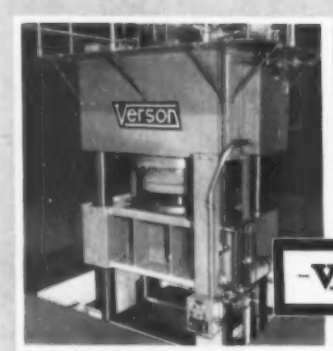
Giant 1000 ton Verson down-acting hydraulic fiberglass molding press. Working area is 100" x 192".

150 ton Verson up-acting hydraulic reinforced fiberglass molding press. Working area is 50" x 74".

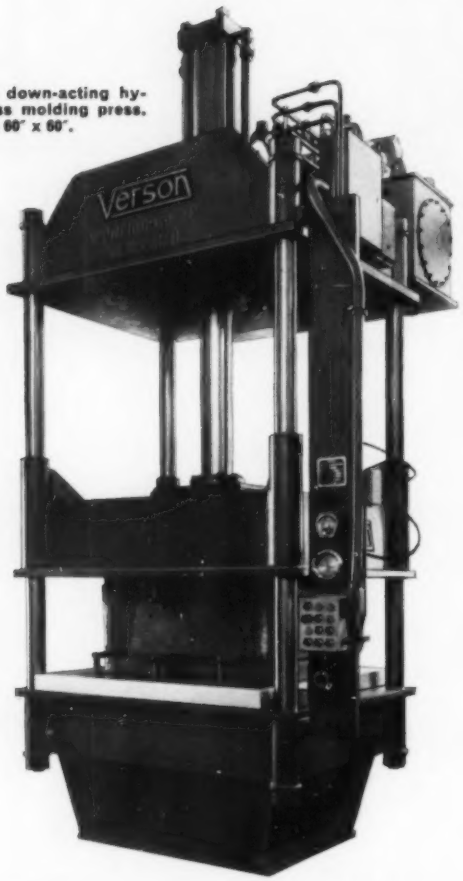


50 ton Verson up-acting hydraulic transfer molding press. Working area is 12¼" x 36".



600 ton Verson down-acting hydraulic compression molding press. Working area is 48" x 60".

150 ton Verson down-acting hydraulic fiberglass molding press. Working area is 60" x 60".



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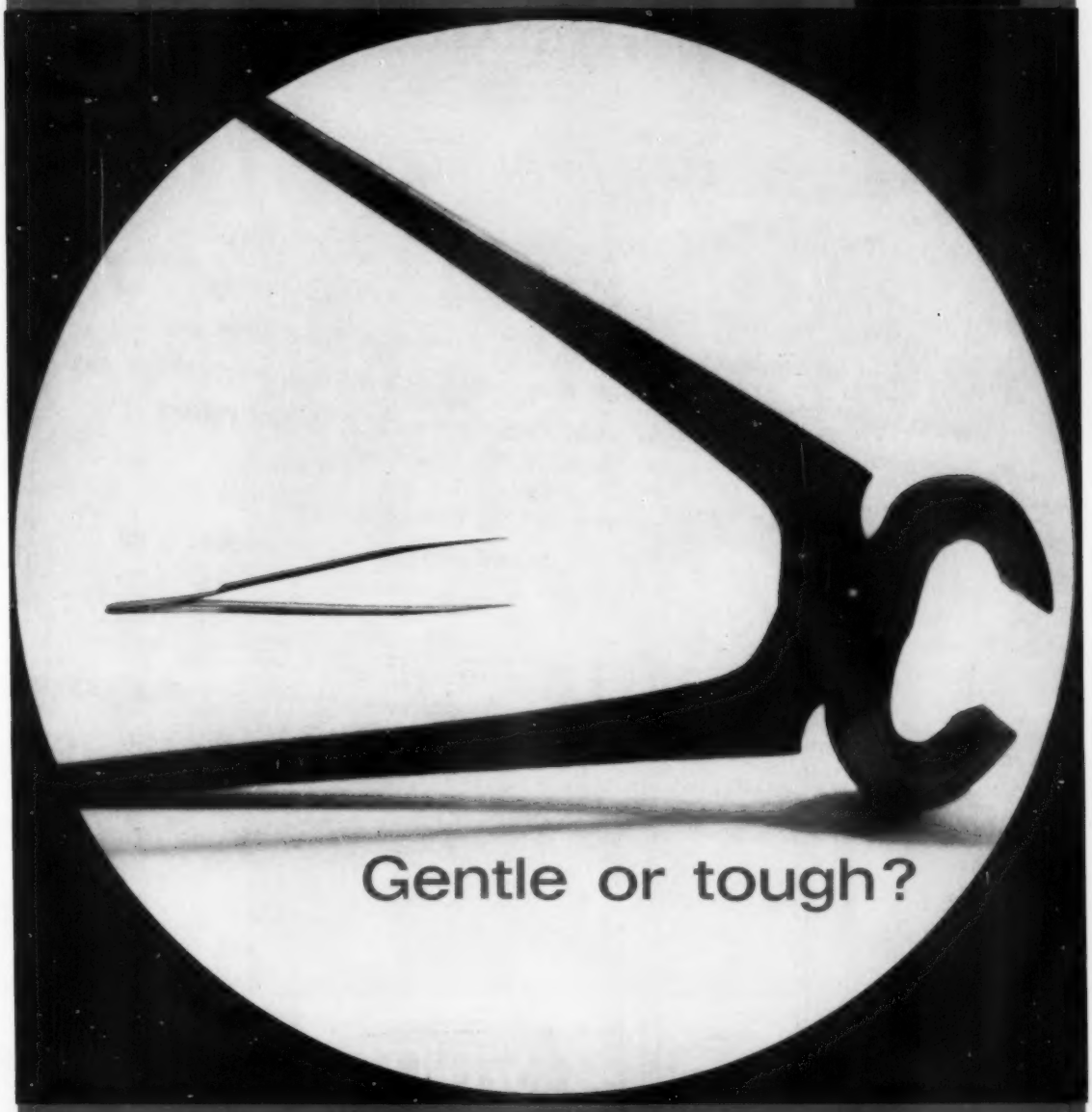

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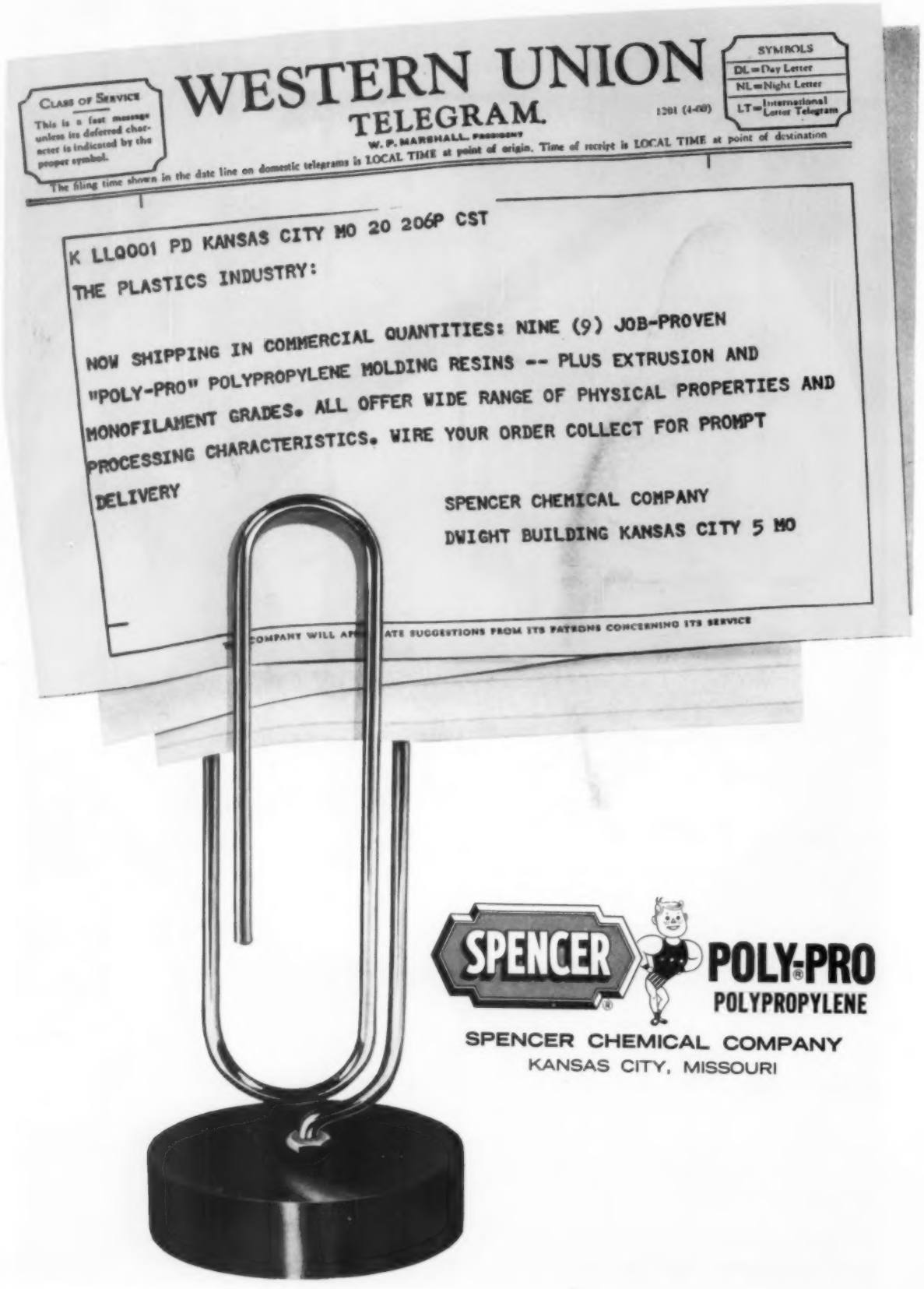
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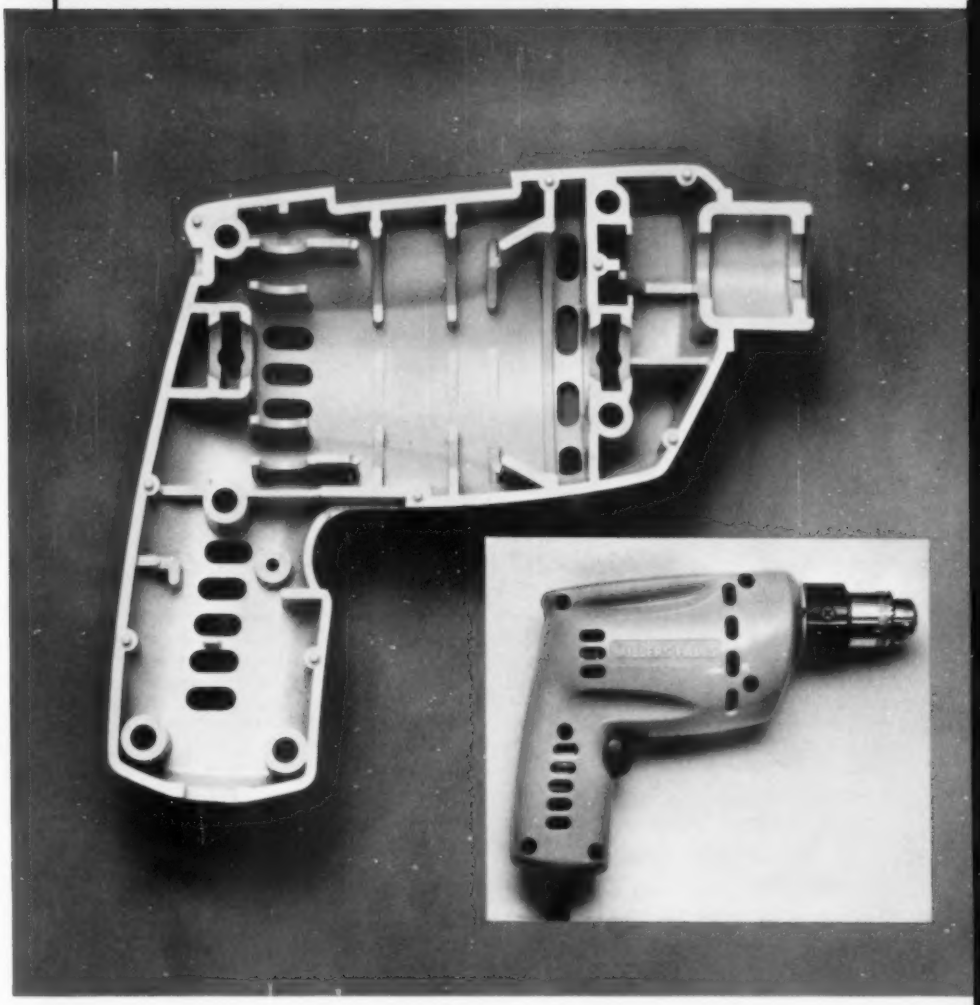

New drill housing of ZYTEL® NYLON RESINS insulates ...eliminates costly machining operations

A basic design advance in power tools, this ¼" drill is made with a nonconductive housing of Du Pont ZYTEL nylon resin. Double-insulated, it protects the user against shock hazard. Other design advantages include a weight saving: the housing of ZYTEL is 20% lighter than a comparable housing of aluminum. It is self-extinguishing. It stays comfortable to the touch in hot and cold weather and after prolonged use. It is rugged, durable and impact-resistant.

In addition, the use of ZYTEL affords substantial production advantages. The two halves of the drill housing, though complex in design, are quickly and easily molded. The excellent dimensional stability of ZYTEL assures a perfect match of each half for screw inserts, assembly and flange matings. And the housing requires no machining operations whatever.

Molded by Nylon Products Corp., affiliated with F. J. Kirk Molding Co., Clinton, Massachusetts, for Millers Falls Company, Greenfield, Mass.

On the following page you will find additional examples of practical design improvements made possible by the combination of properties that ZYTEL nylon resins offer.

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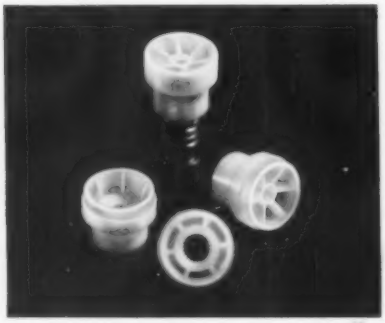
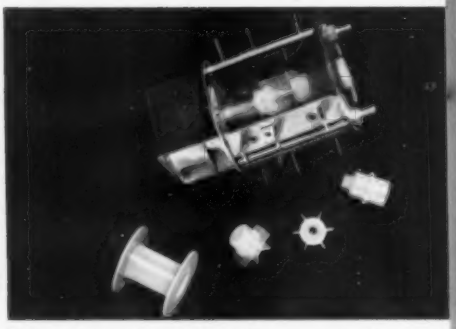
one of Du Pont's versatile engineering materials

Parts of ZYTEL® NYLON RESINS perform reliably under attack by heat, impact and chemicals

This oil slinger swirls oil onto vital engine parts. It must be tough, resistant to impact, abrasion and attack by oil at high temperatures. ZYTEL provides all these resistant properties and permits economical injection molding of the part. (Molded by Sinko Mfg. & Tool, Chicago, Ill., and Danielson Mfg. Co., Danielson, Conn., for Briggs & Stratton, Milwaukee, Wis.)



These faucet-handle inserts are designed for interference-fit assembly and to act as an insulator against heat. These rugged parts of ZYTEL will withstand 116 inch-pounds torque at the stem between 20° and 160°F. They are expected to give at least 20 years of efficient service. (Molded for American Radiator & Standard Sanitary Corp., New York, New York.)



This compact switch relay uses parts molded of ZYTEL to withstand rugged treatment and yet operate quickly, smoothly and positively. Necessary in this application are good heat resistance, good electrical properties and high strength in thin sections. ZYTEL fills the bill. (Molded by Ritepoint Pen & Pencil Co., for Warco Industries, both of St. Louis, Missouri.)

An important factor in the design versatility of ZYTEL nylon resins is their ability to be molded to accurate tolerances without costly machining. Equally important is the wide variety of ZYTEL nylon resins available to meet special problems. All ZYTEL compositions have the basic properties of low friction, impact and abrasion resistance, high strength and resistance to chemicals.

Du Pont ZYTEL may help you, too, to improve the performance or the economics of a part or product. The coupon below will bring you information relating to your own problem or field of interest.

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We then offered to furnish him an improved mold, designed for his needs and tested by us **on his own machines.** Result — he now gets 16 combs per "shot" instead of 8, semi-automatic instead of hand de-gating, and a 26% shorter cycling time. No more grinding or buffing, either... for a yearly saving of more than $100,000!

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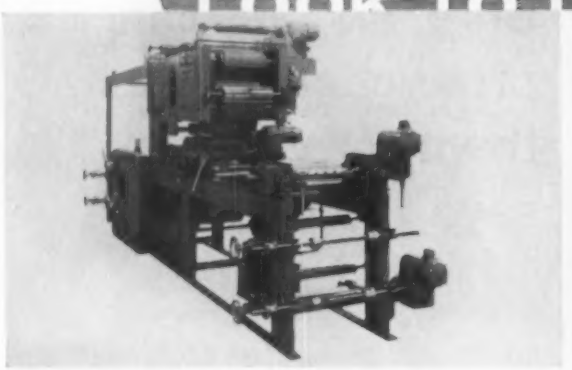

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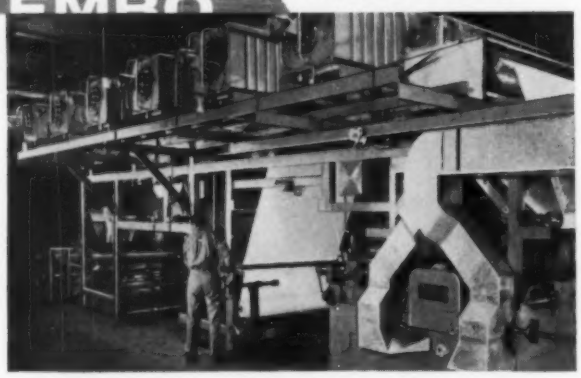

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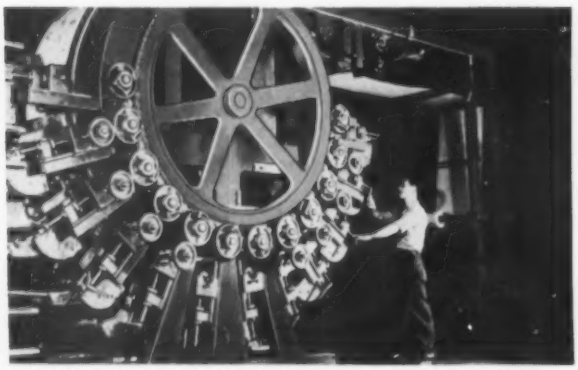

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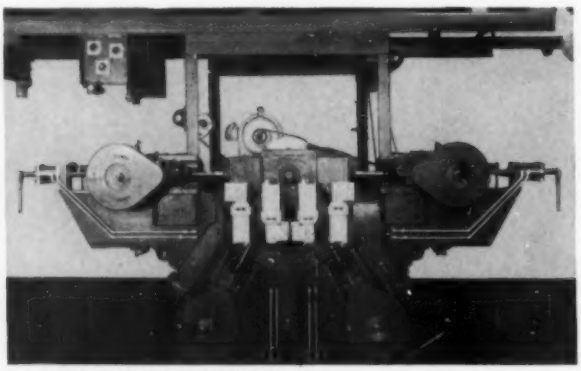

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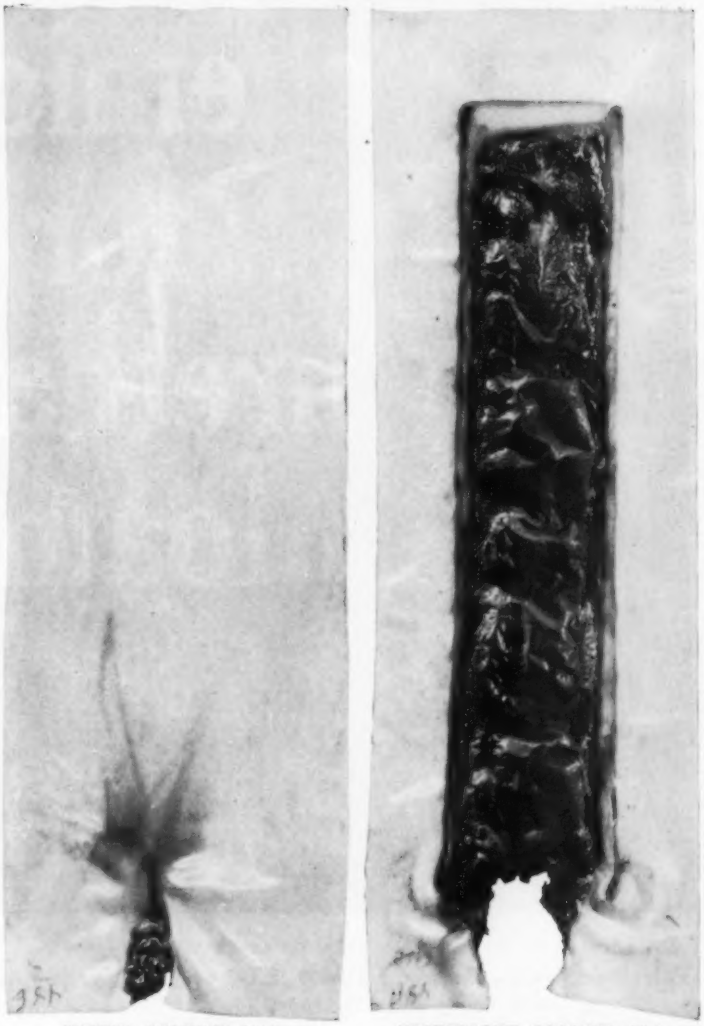

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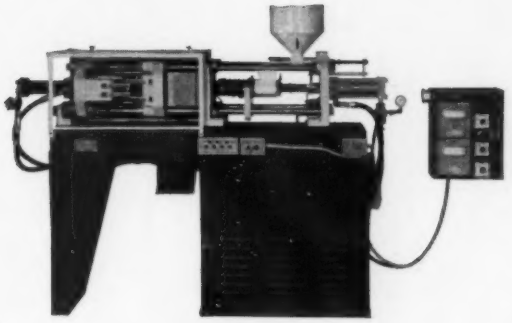

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MODERN PLASTICS

April 1961 **Volume 38, Number 8**

Processing research needed

According to the Annual Construction Survey of the Manufacturing Chemists' Association, more money has been budgeted for chemical plant and laboratory construction in 1961, than in any previous year: $733.2 million for plants, $39.2 million for laboratories.

This in spite of present overcapacity in many materials.

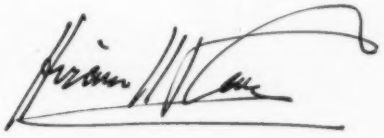
There are three obvious reasons for this development. First, there is the need for intensified research to develop new and more profitable chemicals and resins and lower cost and more efficient methods of making them. Second, there is the growth of potent foreign competition in new plants which are naturally more modern than American plants constructed only a decade ago. Third, of course, is the predicted upswing in the whole economy, but especially in the use of the organics of which plastics are an important part.

So the chemical industry is tuning up and building up to maintain and increase present markets and to build new ones.

What of the plastics processing industries? How many of our molding machines, extruders, calenders, and thermoforming facilities are obsolete? How much research into processing methods and equipment is going on in processing plants? Admittedly, the raw materials makers represent big money and most processing plants relatively small money. But the fact is that all over Europe and even in Japan processors are putting their money into such research. Which accounts for much of the process and equipment cross-licensing going on.

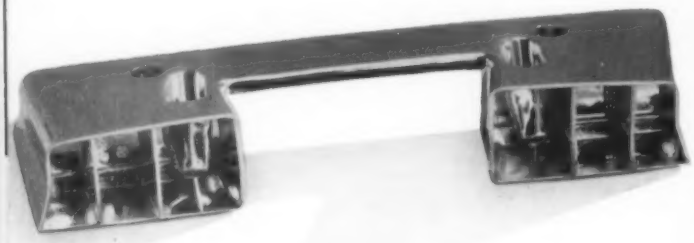
We believe that the American plastics processors, if they hope to develop export markets and even to compete here in the United States with imported plastics products and components, will be well advised to put some of their own money into such research.

Thus, they will be in a better position to take advantage of the results that will come from the new laboratories and plants of the raw materials producers.



NEW ADDRESS: Executive, Editorial, and Advertising headquarters offices of MODERN PLASTICS are now located in our new building at 770 Lexington Ave., New York 21, N. Y. Telephone and teletype numbers remain the same: Phone, PLaza 9-2710; teletype, TWX-NY 1-3063. Cable address: "Breskinpub, New York."

HOUSING for Raytheon shipboard radar antenna (extending to left) measures 5 ft. by 10 in. by 12 in. It is formed in two parts by Gregstrom Corp., Cambridge, Mass., then parts are cemented to an extruded I-section for watertight seal. ABS won this application because of its good microwave transmission, light weight, and cold-weather resistance. Photo, Marbon Chemical



AUTO ARM REST uses intricate molded-in ribbing for strength and molded-in mounting holes to facilitate assembly to car. Entire unit is metallized for high-style appearance. Photo, Monsanto Chemical

Where is ABS headed?

With new suppliers entering the field and with capacities slated to increase manyfold, what are the market prospects for acrylonitrile-butadiene-styrene? What are the economics? The property claims? The successful applications?

Behind all the hectic activity that's going on in ABS (acrylonitrile-butadiene-styrene) lies one basic prospect: a market upheaval that may catapult a 45-million-lb.-a-year resin in 1960 to a 300 to 500-million-lb.-per-year material before the end of this decade. This optimism explains the fact that the two original producers—U. S. Rubber and Marbon Chemical—have now been augmented by two more: Monsanto and B. F. Goodrich Chemical; and that additional suppliers can be expected to enter the field before long. Among them: Union Carbide Plastics, which is working on several formulations; Dow Chemical, which reportedly has material out for test; Foster-Grant, which is said to be concentrating its R & D on a limited range of compounds.

Total ABS capacity by the end of 1961 is estimated at 125 million lb., broken down as follows: U. S. Rubber—35 million, Marbon—35 million, Monsanto—40 million, Goodrich—15 million. This capacity is generally believed to incorporate built-in expansion that could double it as demand increases.

Some major markets

What are the markets that will absorb such tremendous resin production? Several goals have been set by the industry; others, while not defined, are implicit in the material's properties.

1. Refrigerators: This market, in the form of inner door liners, crispers, breaker strips, etc., has, until now, been almost completely dominated by impact polystyrene, with 1960 consumption estimated at about 60 million pounds. Food cabinet liners, weighing about 2½ times as much as door liners and traditionally made of metal, are also turning to plastics, and represent a market potential of 120 million pounds. ABS makers are after these markets, and expect to capture a considerable share of the volume. The reasons: First, they feel that their material offers better impact strength, abrasion resistance, improved stress crack resistance at low temperatures, and superior resistance to fatty foodstuffs. Secondly, unlike impact polystyrenes, their material will not be attacked by fluorocarbon-blown urethane foam, the newest and fastest growing insulation material for the refrigerator industry.

However, this adoption of urethane foam in itself does not assure an ABS market in refrigerators. Hotpoint, for instance, instead of going to ABS, tackled the problem by enclosing the foam in a film laminate pouch so that there was no contact between foam and polystyrene housing. It is also conceivable that urethane foam formulations will be developed that do not attack impact polystyrene. And economics are, of course, still a stumbling block. Even at the lowest price, ABS sells at more than 10¢/lb. above high-impact styrene. However, considerable development is in progress to design refrigerator components with thinner sections, but the same strength as current parts, so as to make them competitive. This plus the cold-resistant properties of ABS, tend to make the producers hopeful.

2. Automotive: ABS has started to penetrate this industry in recent models, although on a relatively modest scale. However, one supplier sees an automotive market for ABS of about 100 million lb. by 1965.

In terms of specific applications, another company offers the following, more conservative, potential breakdown, covering formed and molded units:

Unit	Million lb.
Seat backs	3
Wheel housing covers	3
Pillar post covers	4
Crash pads	8
Seat side panels	3
Headliners	5
Armrests, garnish molding	8

Two more applications of less assured acceptance could send the market soaring:

a. Instrument clusters: The advent of the die cut "printed" circuit, the excellent moldability

FIAT AUTO and ABS parts used in it. Included are dashboard (held by model), garnish molding, and steering column cover.

Photo, Naugatuck Chemical

Photo, B. F. Goodrich

DOORLINER and shelving of ABS sheet are toe in door of refrigerator market that consumed an estimated 60 million lb. of all materials during 1960.

of ABS, plus its good heat and cold resistance properties, all point to good-size penetration. One experimental panel of ABS, produced by Packard-Electric, has aroused considerable interest among automotive engineers. Produced on a 200-oz. machine, about 4 lb.; this represents an annual potential of 20 to 24 million pounds.

b. Hubcaps: This is a market that is still solidly in steel, but several producers are working on the possibility of switching them to metallized ABS. Weight of ABS hubcaps is about ½ lb., for a total potential of 10 to 12 million pounds.

3. Tote boxes: This is already a firmly established market and includes both formed and injection-molded units. Industry has been using them all along. Now a recent impetus has been added by the Post Office modernization program aimed at bringing a degree of automation to the Federal mail service. The molded ABS tote boxes are used to transport sorted mail from one station to another, and each consumes over 2 lb. of resin. The Army, Navy, Air Force, and other government agencies are considering adoption. Trade observers feel that a realistic potential might be 12 million lb. of resin per year by 1965, perhaps double this, if business adopts the box for use in its mail rooms.

4. Boats: Because of the large poundage per unit, the potential for this market may be close to 10 million lb. per year, by 1965.

ABS boats are currently formed from ABS face-ABS foam core sandwiches. A sandwich for a typical 19-ft. boat has the following construction: One ply of outer skin, 20 mils thick. This is ABS sheet compounded with chlorosulfonated polyethylene to impart the necessary resistance to ozone and ultra-violet light. This outer ply is backed by three plies of straight and one ply of modified ABS. The competitive position of ABS versus polyester-glass boats is not clear. In some hull construction, they are about the same in cost. Generally, ABS boats are 20% lighter.

There are five boat makers who currently produce ABS craft, ranging from canoes to 19-ft. units. At the present time, sheet (and thus boat size) is limited to 20 feet. Average weight per boat hull is approximately 120 lb. of ABS. 1960 sales were about 2000 boats, for a total consumption of ABS of a little over ¼ million pounds. By 1965, estimates are for 60,000 units.

5. Communications: The new, personalized telephone, with its range of decorator colors, has

ABS in Europe: imaginative

The paradox of ABS in Europe is that, in spite of a relatively modest volume (1962 capacity is estimated at 15 to 20 million lb.), the material has pioneered many applications that have subsequently been adopted in the United States, and many others that still have not reached our shores. Typewriter machine housings are a typical example. Remington introduced an ABS-housed unit here in 1960; but prior to that year, several European typewriter companies had already made the switch . . . and now they're working on double-shot injection-molded ABS typewriter keys.

Automotive applications have also come a long way in Europe—while they have barely gotten off the ground in the United States. One 1960 Fiat model incorporated 12½ lb. of ABS, and such makes as Renault, Simca, Citroen, and others are all using the material extensively. European ABS car potential alone is estimated at 10 million pounds.

And here are some of the more exciting current European applications (some developmental, but most commercial) that have not yet found acceptance here: Car door handles; institutional dinnerware, used in one of the

dramatized the switch from cellulosics and phenolics to ABS in this field. All telephone companies are now using the material for all their colored units. (Black sets are still produced in cellulose propionate.) The total volume for this market is 7 million lb. per year, of which ABS's share in 1960 was 4 million pounds. If the trend to color continues, a market of about 10 million lb. within a few years is possible.

6. Luggage: Here is a market that ABS producers have been after for some time. Sales in 1960 are estimated at about 2 million lb., but all observers are agreed that this is just a drop in the bucket. The features underlined by the producers are good high- and low-temperature resistance, plus economy that can be achieved by way of reduced assembly operations. Most ABS luggage today is formed. Injection molding, which would permit molded-in mounting holes and flanges, would really make them economical, but has run up against the problem of tooling cost. Almost all luggage lines contain five or six models, each one of which represents a relatively short run.

If, and when, resin prices come down and the

Photos, Naugatuck Chemical

HOUSING of GE portable mixer takes advantage of exceptional dimensional stability of ABS to assure perfect fit of compound curvatures of mating components. Parts are made on molds originally cut for cellulosics.

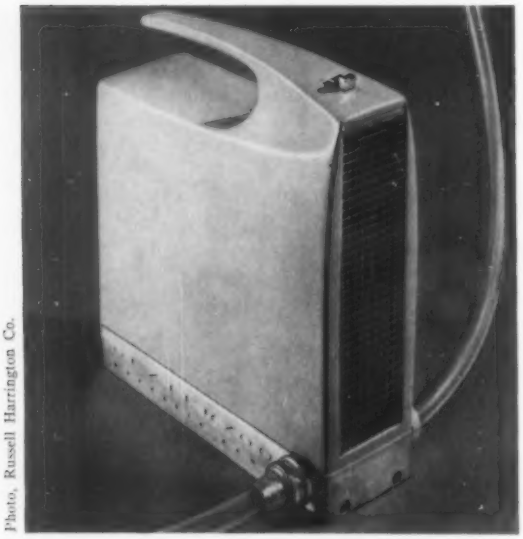
applications broaden market

Scandinavian countries because the higher production rates possible with ABS made it lower in cost than melamine, and because ABS met the specifications governing this particular application; mailboxes, see photo, traditionally made of metal; knife handles; leaders and downspouts; machine housings for such large equipment as Linotype units; and even a blow-molded bottle for lighter fluid.

As far as is known at the moment, only two companies are in commercial ABS production in Europe: S.P.E.M. Ugine of France and Farbenfabriken Bayer of Germany. Both companies produce the material under license from U. S. Rubber, Naugatuck Chemical Div. Other U. S. Rubber licensees are A.N.I.C. in Italy and I.C.I. in England; however, neither company has as yet gone into commercial production. Also reportedly in the ABS field, but also not yet commercial, are Badische Anilinewerke in Germany and Montecatini in Italy.

Until about three years ago, European countries had placed very high tariffs on imported ABS material. Since then, the material has gotten favorable classification in many areas and has now started to move. Substantial volumes of U. S.-produced ABS are expected to be sold in Europe. But as European production is stepped up, U. S. exports to that region will, of course, diminish. However, no ABS imports from Europe—or other countries—into the U. S. are expected for the next 10 years.

COLORED TELEPHONES, such as this Starlite model, are a major market for ABS resin. Resin's easy moldability also makes possible double-shot injection molding of dial plate shown.



Photo, Russell Harrington Co.

BILGE PUMP housing is recent ABS application. Material was chosen because it is tough enough to withstand the abuse encountered in boating activities.

Photo, Naugatuck Chemical

FISHING REEL has housing and body of ABS. Material was chosen for toughness, moldability to close tolerances, and processing economics which make it competitive with imported types.

economics are more competitive, a luggage market of perhaps 10 million lb. may be realized.

7. Shoe heels: While a small per-unit resin consumer, shoe heels use up an impressive resin total. In 1960 ABS accounted for 7 million lb. of a total of 20 million lb. of material consumed. But no spectacular growth for ABS is foreseen in this stable market.

8. Pipe: It is estimated that for 1960, about 10 million lb. of ABS were used for pipe. However, there is considerable growth potential here; and with the recent price reductions for pipe resin (Type I now sells for 44¢/lb., Type IA for 47¢/lb., and Type II for 54¢/lb.), much of this potential will undoubtedly be realized. The principal growth markets for ABS pipe are listed in Table I on p. 156.

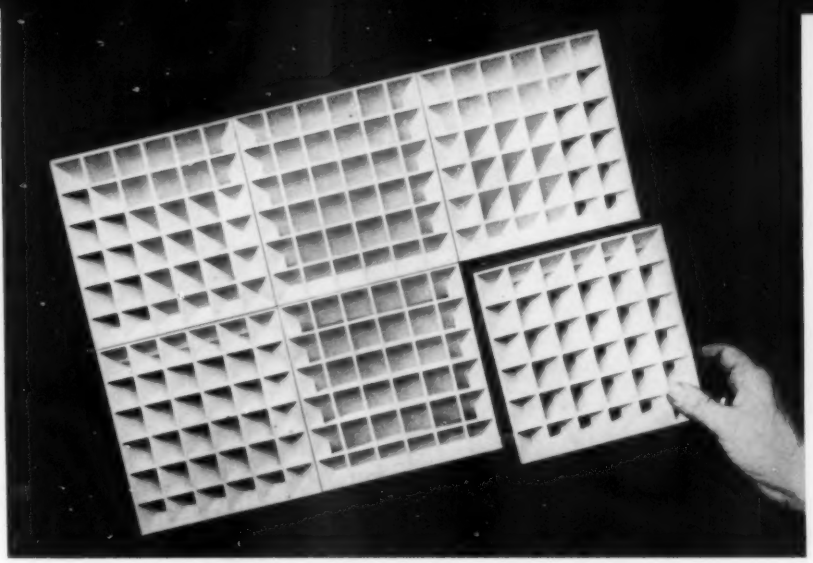
Reasons for ABS's strong competitive position can best be pointed up by an analysis of how ABS pipe stacks up in only one of its many end-use areas: municipal water service. There ABS competes against asbestos-cement.

In a study completed late in 1960, the costs shown in Table II (p. 156) were established. As can be seen, only in the 6-in. size is asbestos-cement lower in cost. Since this study was made, some of the ABS pipe resin prices have come down as much as 10%, so that the pipe is now almost competitive in the 6-in. size.

Other end-use areas would include such complex piping applications as underwater cable installations (river and channel crossings). More often than not, multiple duct is used (clay and cement are fabricated in this fashion), so that future cable demands can be satisfied without the necessity of installing more conduit.

Taking all these market factors into consideration, a 20-million-lb. market for ABS pipe by 1965 seems to be a reasonable forecast.

9. Miscellaneous: About 8 million lb. of ABS were used in 1960 for appliance housings, radio cabinets, sporting goods, business machine housings, safety helmets, and the like. This market may well double in size by 1965. There is also a 5-million-lb. market in extruded shapes, which are used on textile machinery, storm window tracks, glazing frames, and the like. No spectacular growth in this area is expected. Together, these markets repre- **(To page 156)**



AIR DIFFUSERS are molded of polycarbonate to provide integral color and dimensional stability under variety of temperatures. Switch from metal also eliminates finishing. Different modules in photo to show how three-directional flow of air can be obtained from single duct.

Polycarbonate replaces metal

Switch gives manufacturer of air diffuser added advantages of greater design flexibility, lighter weight, and integral color—at competitive cost

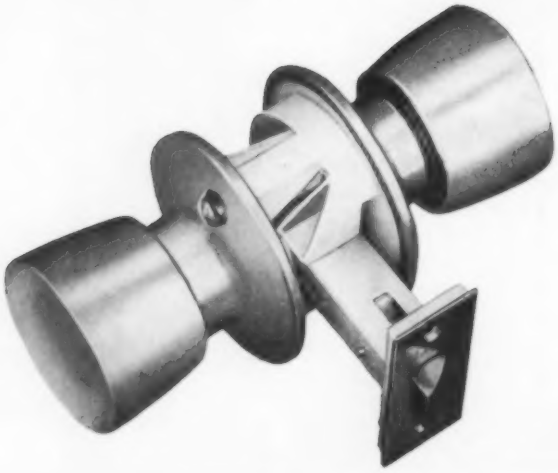
Modular air diffusers, injection molded of polycarbonate material, providing flame resistance, dimensional stability, and resistance to breakage, were recently introduced to the building field by Carnes Corp., Verona, Wis. Molded in an off-white color and measuring 6 in. square, the plastic units weigh approximately 2½ oz. each. On this basis, an air conditioning and heating installation in a single large commercial building may conceivably involve hundreds of pounds of the polycarbonate type plastic.

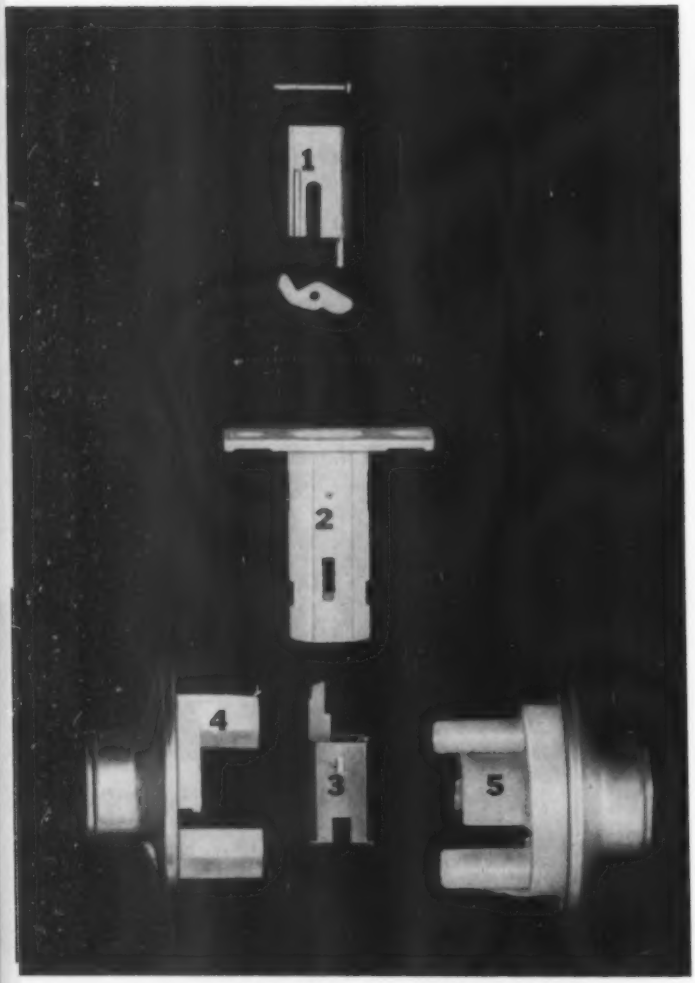
The new diffusers supplement metal diffusers also available from Carnes, which specializes in heating and ventilating components. With injection molding, it is possible to produce diffusers which are complete when withdrawn from the mold, requiring no painting or other finishing operations. Sales cost of the plastic diffusers, despite the considerably higher price of the molding material, is competitive to that of the company's line of diffusers.

In addition to integral, molded-in color, which can't wear off in service, the plastic diffusers are easier to clean than metal units and permit greater freedom of design treatment. If dropped during installation or removal for cleaning, they are not subject to bending or breaking. Their pleasing design results in an unobtrusive type of installation, which adds to the attractiveness of the ceiling in which they are installed, and is in line with modern architectural trends.

The molded polycarbonate diffusers are made in three basic types having identical over-all dimensions. These include (see photos) the corner blow, the one-way blow, and **(To page 174)**

DIFFUSERS installed in window/perimeter air conditioner. Diffusers, said not to attract dust, snap out for easy cleaning.





REVOLUTIONARY LOCKSET (top photo) incorporates molded nylon parts shown above. Latch assembly consists of only five moving parts: Latch shoe case **(1)**, cam **(2)**, and bolt **(3)** are all injection molded of nylon resin; chassis sleeves are molded with round **(4)** and square **(5)** grooves to assure perfect match and to prevent mis-assembly.

New market:

The recent introduction of several new design concepts for door hardware mark the first breakthrough by plastics materials of a market that until recently was completely dominated by metals. And while the initial penetration is not earth-shaking in total volume of resin consumed, it does bring the plastics industry to the threshold of new and potentially large markets. The specific products: locks, knobs, spindles, and hinges.

What is of particular significance in this development is that the new concepts are not just imitations of metal parts in plastics. On the contrary, they involve new design ideas that result in better performance, simplified assembly, lower cost, as well as longer life.

Unique lockset in nylon

There is, for example, a new nylon lockset just introduced by Lockwood Hardware Mfg. Co., Fitchburg, Mass. Until this product came to market, locksets were essentially made up of lubricated metal parts. These in time corroded, wore out, and presented other performance shortcomings. In addition, their installation was one of the trickiest operations builders had to perform. For the do-it-yourselfer this was a well-nigh impossible task.

The new nylon lockset can be installed easily. In addition, it provides several functional benefits. The resilience and low-friction characteristics of nylon contribute quiet operation and eliminate the need for lubrication. Tests reported by Lockwood indicate undiminished "lubricity" after 1.2 million cycles, the equivalent of 80 years' use. In fact, the sets worked smoother at the end than when the tests were started.

The internal mechanism of the nylon locksets cannot rust and is unaffected by warm and humid climates. Because there is no functional steel-to-steel contact, the possibility of electrolytic corrosion is eliminated. There is automatic compensa-

Molded and extruded parts have started to show up in a field that until recently was completely dominated by metals. Three case studies shed light on this new trend

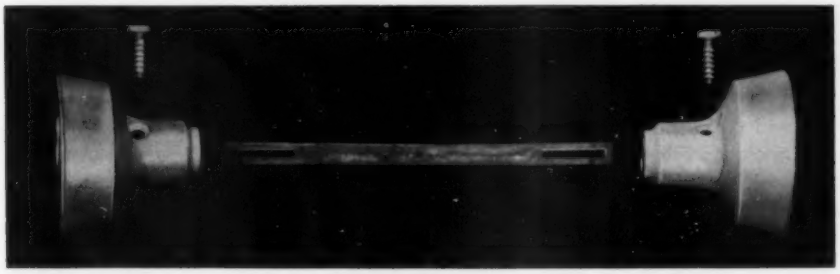
door hardware

tion of normal contraction and expansion of door wood—the inherent elasticity of nylon keeps the central lock assembly under tension. This elasticity also virtually eliminates the possibility of the throughbolts backing out due to vibration or repeated slamming of the door.

Accidental mis-assembly is impossible. The inside and outside chassis units are so designed that one half of the assembly has round and square sleeves which must be positioned to mate with round and square grooves in the other half. The entire set is held by two double-lead throughbolts which drive directly into tapholes in the chassis sleeves. Threads cut into the nylon sleeves cannot strip under normal installation conditions.

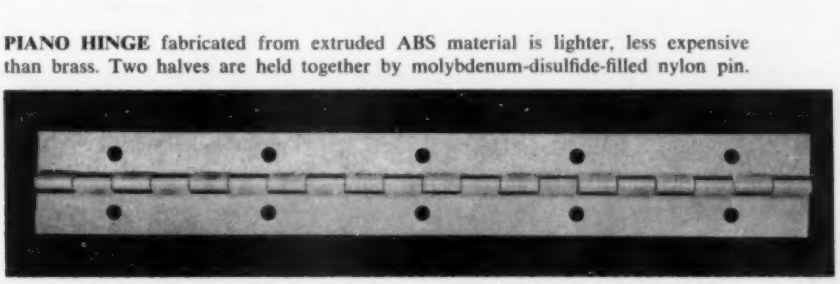
The components, which are identified in the accompanying illustrations, are molded by Nylon Products, Clinton, Mass., using nylon-6/6 material. All internal parts for the lockset are produced in natural color, while the visible bolt is molded in a bronze metallic color that is designed to match the cover plate.

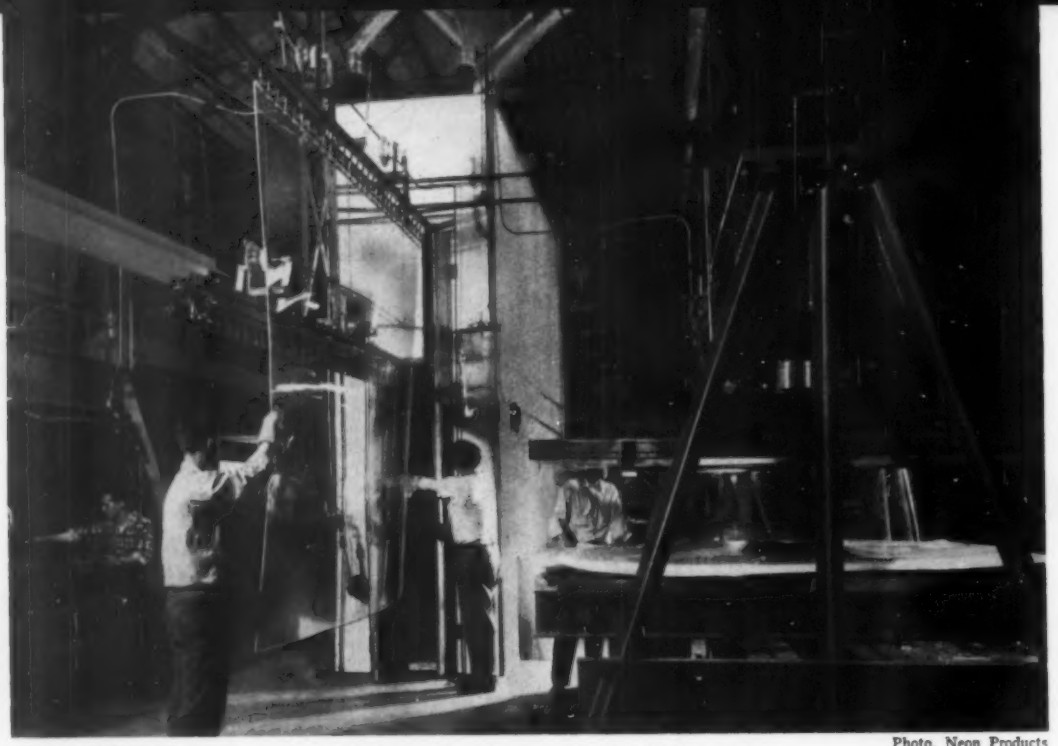
While the new nylon locksets are somewhat more expensive to make than standard locksets, their initial cost to the user is about the same (and their ultimate cost definitely lower). Lockwood Hardware feels that it is pioneering a new market which someday may blanket a large portion of the lockset field; it is, therefore, at this time willing to absorb the increased cost. It should be noted, however, that the extra cost is small, despite the fact that nylon is higher-priced than the metal previously used. Some of the increased materials cost is offset by the **(To page 162)**



DOOR KNOB SET consists of two compression-molded knobs and injection-molded nylon spindle. Note that spindle, unlike conventional designs, has no threads. It is held to knobs by set-screws into molded-in slots.

PIANO HINGE fabricated from extruded ABS material is lighter, less expensive than brass. Two halves are held together by molybdenum-disulfide-filled nylon pin.





Photo, Neon Products

ACRYLIC SHEET, a prime material in sign making, is removed from heating oven ready for positioning on press at left. Another sheet is already in position on press, at right, ready for clamping and forming.

The new look in signs

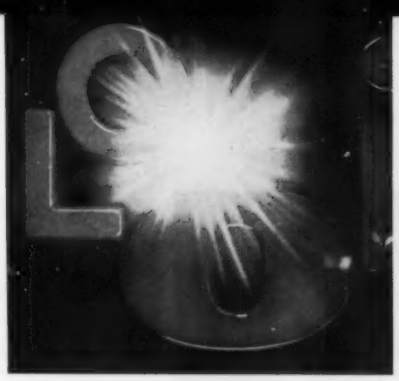
Imaginative approaches to the design and construction of signs and displays push plastics into the top slot in this lucrative market

In the period since the end of World War II—a period coinciding with merchandising demands for the colorful, the unusual, and the original in signs and displays—plastics have come on so strong that today they are the acknowledged leaders in the field. The importance of the sign industry to the plastics industry, however, is not in terms of volume alone. Designers of signs and displays have shown a refreshing approach to the adaptation of plastics that has influenced the workings of other industries. Many of today's developments in thermoforming stem from original work done with signs and displays; the art of preprinting in distortion was similarly perfected by the sign makers; and the reverse-surface decorating techniques now used for escutcheons, medallions, etc., owes much to the field, as does the technology of designing with the light-transmitting properties of the transparent plastics.

There is much that many industries can continue to learn from some of the more recent developments described below. The concept of trans-illumination (as shown by the photo on p. 92), as just one example, offers an entirely new approach to lighting problems—no matter what industry is involved.

A volume market

According to a recent *Wall Street Journal* survey, plastics units now account for more than 50% of all sign sales. Five years ago, they had only 10% of the market, with the remainder firmly entrenched in the stronghold of neon tubing. And it's far from the end for plastics. In-



COVER: Light, color, and thermoformed lettering—three major components of modern signs—are combined here to capture the essence of this booming plastics market. Acrylic letters courtesy of Universal Unlimited Inc., Glen Cove, N.Y.

dustry sources are now estimating that 75% of the signs made during the 1960's will be of plastic construction. Evidence of this trend can best be seen in the recent activities of such leading companies in the field as Advance Neon Sign Co., Los Angeles, Calif. Four years ago, the company's entire line was devoted to neon signs; today, 85% is in plastics.

From the volume standpoint, the total market represented by the sign industry is impressive. Aggregate sales during 1960 reached approximately $500 million. Currently, there are some 6000 companies in the field, ranging from small firms with a handful of employees to major concerns having complete facilities for production of metal, electrical, and plastic components.

Why the trend to plastics?

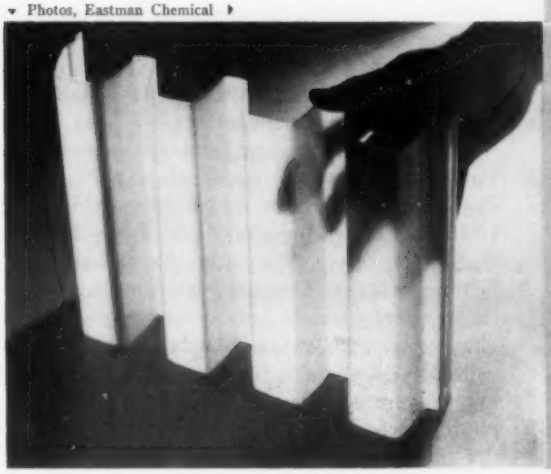
What accounts for the rapid growth of plastics in the sign and display field? Out of many factors which might be cited, five are most important:

1. Plastics combine such properties as built-in color, light weight, optional transparency or translucency, resistance to corrosion, as well as the ease of fabrication.

2. Plastic signs are economical. According to one major producer, materials for a typical plas-

DOUBLE-FACED sign, internally lighted, measures 25 by 40 ft., stands 52 ft. high on frame. All copy and illustration are made of colored butyrate sheet overlayed on white translucent corrugated background (see left).

▾ Photos, Eastman Chemical ▸



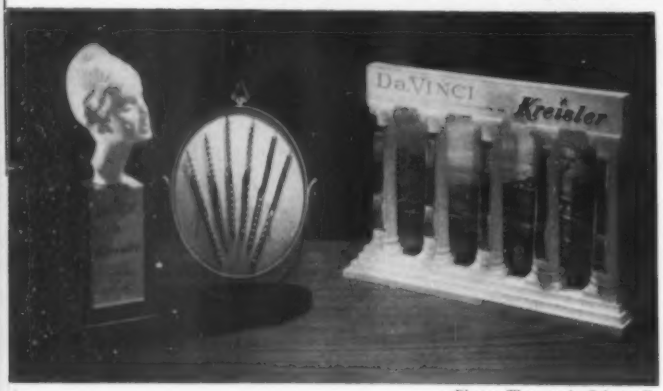
CORRUGATED butyrate sheet is sample of type used in 40-ft. sections to form background of sign shown in the illustration above.

TRANS-ILLUMINATION is recent development in large outdoor signs, combines acrylic sheet background with copy printed on polyester film (see below).

Photos, Advance Neon Signs

POLYESTER FILM bearing sign copy is stripped onto acrylic panel which forms background of sign. Panels, with copy in place, are installed in billboard frame in field.

DESIGN FREEDOM inherent in plastics materials and processing techniques make possible sign-displays such as these at relatively low cost. Production of these employed blow molding, injection, and vacuum forming, plus molding of styrene foam base for display at left.



Photo, Thomas A. Schutz Co.

tic sign are approximately 25% less costly than for a comparable neon unit. Shipping cost is also reduced; a 3-by- 6-ft. plastic sign weighs about 120 lb., compared to 275-300 lb. for neon. The weight advantage, plus greater durability of the plastic unit, yields a saving of about one-fifth in shipping. The lighter weight also means less costly supports and mountings are needed. Finally, maintenance costs on plastic signs are much lower than on fragile neon signs.

3. They offer exceptional design freedom, making it possible to incorporate contours and details which give free range to the talents of the designer. Vacuum- and pressure-formed sheet plastics fill the gap between cardboard and molded plastics. Pre-decoration, low-cost molds, and the freedom to form large and small, thick and thin materials make plastics tailor-made for the industry.

4. Plastics signs work around the clock. Internal illumination, protected from the elements, gives them powerful visual appeal at night; during daylight hours their brilliant colors command attention and interest.

5. Advances in equipment and fabrication techniques give the sign or display manufacturer an extremely wide choice of production techniques, ranging from injection molding for intricate, smaller-size, mass-production signs (generally 5000 units is the minimum) to vacuum and pressure forming for larger signs of limited runs. Among the newest fabrication methods to enter the display field are expandable styrene molding and blow molding.

What plastics to use?

For outdoor signs and displays, acrylic, with its outstanding optical characteristics, weather resistance and formability, strongly dominates the picture. At present, both the familiar cast acrylic and the newer extruded sheets are being used by sign manufacturers, with extruded now representing an estimated 10% of the total. (See panel, p. 166, for a comparison.)

Of interest is a recent announcement by Du Pont's Polychemicals Dept. of a new methyl methacrylate monomer designated as Monocite H 100, which was developed specifically for production of cast acrylic sheets for the sign and lighting industry. Sheeting cast from this material reportedly weighs only one-third as much as glass, is impervious to all kinds of weather, and will not yellow. Its high impact strength, even at low temperatures, resists chipping, cracking, and crazing, according to Du Pont.

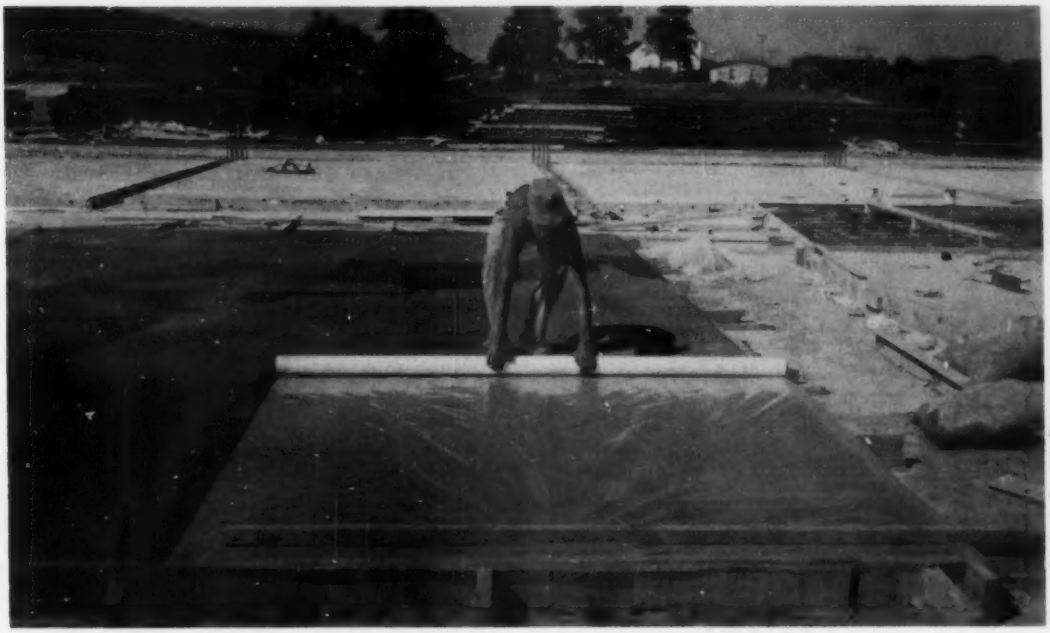
Cellulose acetate butyrate is **(To page 164)**

Road builders in 23 states find they can do a better job

—and in less time—with polyethylene film as a

Cure cover for concrete

By William U. Funk*



Photo, Portland Cement Assn.

PROTECTIVE LAYER OF PE FILM is rolled atop partially dry section of concrete highway. Film prevents too rapid evaporation of moisture in mix which can cause cracking and deterioration. Use of film results in stronger, longer-wearing highways.

Today's super highways are turning out to be super salesmen for the fast-growing use of polyethylene (PE) film by heavy-duty industry. The application that has aroused such enthusiasm by its success is the use of the film as a concrete curing agent cover in highway construction. To date, some 23 state highway departments have published specifications on polyethylene film for this type of construction—and many of the other states have expressed an interest.

Volume-wise, the market represented by this application is a sizable one. Estimates on the amount of concrete highway to be laid over the next 15 years averages out to an annual rate of 1.26 billion sq. feet. Even assuming that PE film gets only a percentage of this total potential market, and even taking into account the re-use factor, the amount of film involved can run well into the hundreds of millions of sq. feet.

As used by road builders, the PE film is laid over the concrete during construction to prevent rapid evaporation and quick drying that could lead to cracks and deterioration in the concrete. In the past, curing methods have consisted either of continuously spraying the concrete with water, spraying the concrete with a special chemical that forms a waterproof membrane, or covering the concrete with straw, waterproof paper, or burlap. Of these, the PE film has thus far proved out to be the most effective, economical, and convenient material. The reasons: polyethylene's outstanding water barrier properties, flexibility, lightness, and durability.

A recent report by the New York State Department of Works on the **(To page 172)**

*Sales Development Engineer—Film, U. S. Industrial Chemicals Co.

CORRUGATED SHEET of hardest grade of PVC-PE blend encloses conveyors at German resin plant.

New polymer blend upgrades PVC

By combining chlorinated polyethylene with rigid PVC, European resin maker develops material with better low-temperature impact strength and better processability than straight rigid polyvinyl chloride

The blending of polymers, by which one or more properties of one or both resins are significantly upgraded, has become a vital tool for the plastics industry. Thus, the industry can offer materials for end-uses which previously were limited because of inherent shortcomings.

Such a material is Hostalit Z, a mechanical blend of polyvinyl chloride and chlorinated polyethylene, produced by Farbwerke Hoechst A. G., Frankfurt/Main-Hoechst, West Germany. Perhaps the most outstanding characteristic of the new material is that it contains no external plasticizer. In this respect, it is much like normal rigid PVC, but it lends itself to easier processing and provides greater impact resistance. The latter property is particularly upgraded at low temperatures. And yet this same unplasticized resin, it is claimed, can be used in applications where a softer, more flexible material, much like plasticized PVC, is desired.

The new plastic resin is supplied in three different grades of hardness, Hostalit Z 820, 840, and 870, and described respectively as "hard/high impact resistant," "intermediate hard," and "soft, flexible." All three are based on suspension PVC. Also available is Hostalit Z 720, which is

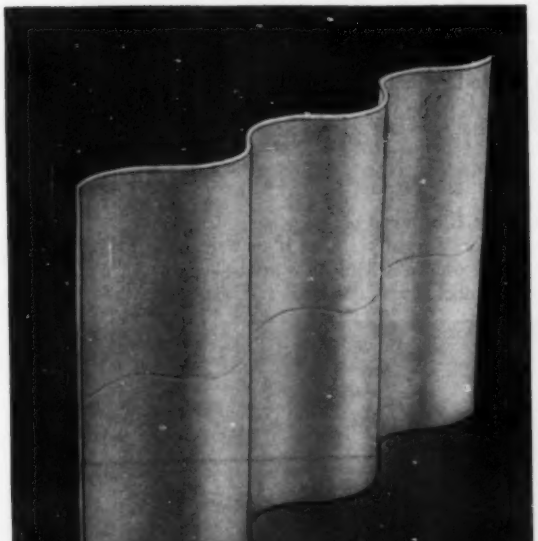
based on emulsion PVC, and is higher in impact resistance than its corresponding 820 grade.

Whether the new material is hard, intermediate hard, or soft depends upon the quantity of chlorinated polyethylene in the blend. The softer the blend, the higher the amount of chlorinated polyethylene. The grades also have different K values. This measurement indicates the degree of polymerization of the PVC resin in the blend. The lower the K value is, the lower the degree of polymerization, and vice versa. Generally speaking, a low K value means easier processing of the blend, while a high K value means higher values in such physical properties as impact strength, tensile strength, compressive strength, and hardness. In the new material, the K value is shown after a slash (/), *e.g.*, Hostalit Z 840/70, or Hostalit Z 870/60.

Application fields

Since the introduction of Hostalit Z in 1959, many interesting applications have been developed or are in the process of development today. Hostalit Z 820/80 has been successfully used in high-pressure pipe, where it is claimed to offer excellent protection from breakage and longer pipe life. Stabilized against weathering, this hardest grade of the blend has been used or tested for many outdoor applications, including: building panels, either flat or corrugated; window frames; jalousies; ventilators; roof gutters and downspouts; sprinkling systems; garden furniture; and traffic signs. Decorative and protective moldings, hinges, table frames, and curtain rods are examples of products featuring the high impact resistance and low burning rate of Hostalit Z for indoor applications.

Because of its high resistance to chemicals, sheet calendered from Hostalit Z 820/60 has found markets as surface covering for laboratory equipment and kitchen furniture. Sheet extruded from this grade can be thermoformed and welded in the usual manner, a fact which has opened up such structural applications as cooling system and chemical duct work. The low burning rate, dimensional stability, and **(To page 173)**



CLOSE-UP of section of corrugated sheet used in installation shown on opposite page. Properties of this grade of the polymer blend are listed in color column of table at right.

PROPERTIES OF POLYMER BLEND*

PROPERTY	UNITS	Three different grades 720/820[1]	840[1]	870[1]
Specific gravity	g./cm.^{3}	1.38	1.38	1.38
Tensile strength	p.s.i.	6,400	5,000	3,270
Elongation (Rate: 100 mm/min.)	%	30	50	100
Compressive strength (Thrust: 100 mm/min.)	p.s.i.	15,650	12,370	8,100
Impact strength	ft.-lb. per in. of notch	13	18	24
Impact strength (at 20°C., 0°C., −20°C., and −40°C.)		Without fracture		
Hardness, Shore D		80	76	69
Thermal conductivity	10^{-4} cal. per sec. per sq. cm., per 1°C. per gm.	5.0	5.0	5.0
Specific heat (at 20°C.)	cal. per °C. per cm.	0.25	0.25	0.25
Thermal expansion (cubic coefficient)	°C.$^{-1}$	3 X 10^{-4}	3 X 10^{-4}	4.5 X 10^{-4}
Thermal expansion (Linear coefficient)	°C.$^{-1}$	1 X 10^{-4}	1 X 10^{-4}	1.5 X 10^{-4}
Heat distortion temperature (at 264 p.s.i.)	°F.	156	154	140
Volume resistivity	Ohm-cm.	10^{16}	10^{16}	10^{16}
Dielectric strength (short-time, ⅛-in. thickness)	Volts/mil	1,400	1,400	1,400
Dielectric constant 60 cycles 10^6 cycles		3.8 3.1	3.7 3.1	3.8 3.2
Dissipation (power) factor 60 cycles 10^6 cycles		0.014 0.037	0.017 0.030	0.022 0.045
Water absorption (24 hr. at 73°F.)	%	0.1	0.1	0.2
Burning rate (ASTM D 635-56T)	in./min.	0.5	0.5	0.5

*Hostalit Z material, supplied by Farbwerke Hoechst A. G. [1]Trade designations of Hostalit Z.

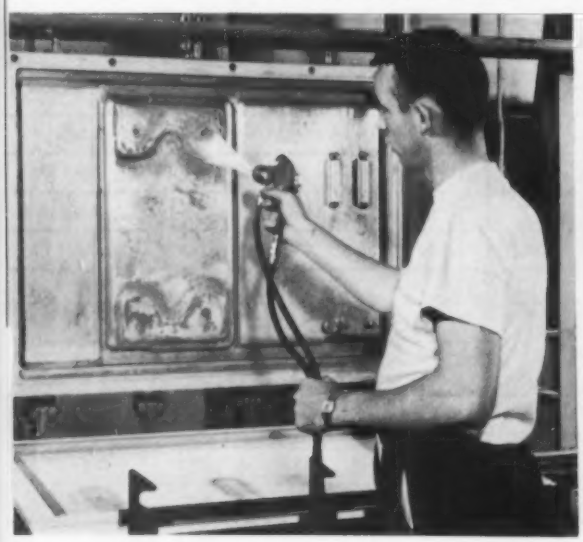
Urethane foam brings back the

Discontinued in 1956, gas refrigerators are now back on the market, thanks to thin-wall urethane foam insulation that brings their cabinet size and storage capacity in line with comparable electric refrigerators

Rigid cellular urethane insulation, foamed in place between the cabinet walls, around the evaporator section, and within the doors of storage and freezer compartments, has made it possible for Whirlpool Corp. to re-introduce the gas-type refrigerator. The gas refrigerator—which featured silent, low-cost operation—has not been marketed since the end of 1956, when it was squeezed off the market by more compact electric models.

The new thin-wall insulation provided a way to incorporate the rather bulky flame-powered refrigerating mechanism into a cabinet providing more storage capacity and improved operating efficiency, and which would match the compactness of electric models. Though only approximately half the thickness of the glass wool insulation formerly used before Servel (the original manufacturer) discontinued operations four years ago, the urethane foam enabled Whirlpool to standardize tooling and produce a gas refrigerator with marketable cabinet dimensions and storage capacity. The superior K factor of the urethane foam (.12 vs. .24 for glass wool) made it possible for Whirlpool to incorporate the added thermal insulation required for a thin-walled, gas-type refrigerator without getting into additional cabinet tooling and related costs. As a result, the company now foresees a sales potential of 300,000 units per year

ALUMINUM COVER, hinged to open side of refrigerator door is sprayed with release agent. Closed, assembly becomes mold for foam insulation.



PRE-METERED CHARGE of liquid pre-polymer is dispensed into inside of door section. Dispensing head is moved in serpentine pattern to obtain even distribution. Hinged aluminum cover is then closed and door moves into oven for foam cure.

gas refrigerator

for the gas units, on which manufacturing rights were acquired from Servel.

As adopted by Whirlpool after an intensive study of possible insulation materials, the urethane foam now being used is based upon a semi-pre-polymer polyether system. This rigid urethane foam provided the answer to Whirlpool's problem—how to effect a large reduction in space between the inner and the outer cabinet shelves and pass the added capacity on to the housewife.

The urethane foam used by Whirlpool has a density when cured of 2.3 lb./cu. feet. Some of its properties are listed in an accompanying table. Although it is more costly than the insulating material which it replaces, the fact that only approximately half the thickness is needed (2¾ in. as against 4 to 4¼ in.) reduces this differential.

Three-step installation of foam

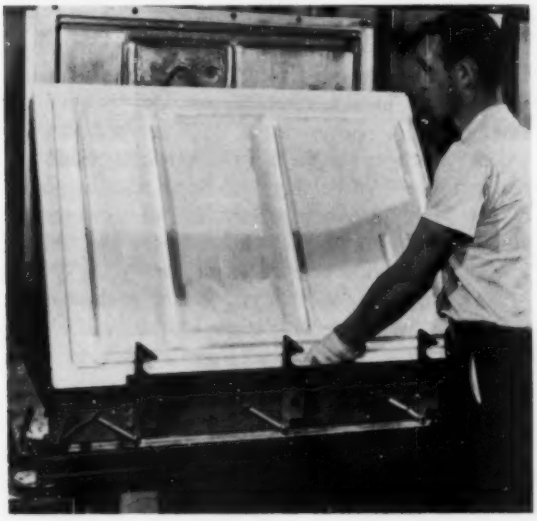
Installation of the urethane foam insulation in the walls, cabinet, and around the evaporator unit of the refrigerator involves three basic steps: 1) preheating the metal part to be insulated, 2) introducing the liquid pre-polymer into the assembly, and 3) curing it through controlled application of heat for a period of approximately 8 minutes. Operations are facilitated through use of conveyor systems which automatically move the assemblies through the various stages.

With doors, for example, the pre-finished door shell, complete with hardware, is placed with inner surface upward on a felt-covered wood pallet, to which is hinged an aluminum cover having contours matching the interior of the finished door. This cover acts as a male mold to form the urethane to the shape and design needed to accept the inner door liner at final assembly.

Before introduction of the pre-polymer, the door shell, moving on a conveyor, is heated to a temperature of 110 to 115° F. as it passes beneath a bank of infra-red strip heaters. Purpose of the pre-heating cycle is to produce a foam having lower density.

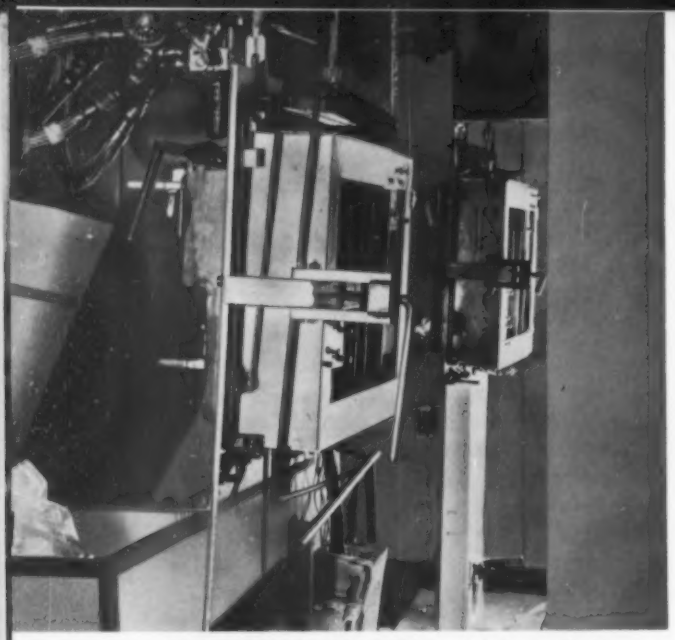
After approximately 2 min. of pre-heating, the door shell reaches the loading station, where the proper amount of liquid pre-polymer (about the consistency of medium sirup) is dispensed into it through a mixing head. Accurately measured in grams, the charge is dispensed in a serpentine pattern in order to deposit an even film of the

DOOR SECTION, with foamed insulation bonded to it, is lifted from mold carrier after 8 min. cure in oven, with contours imparted by aluminum cover clearly visible.

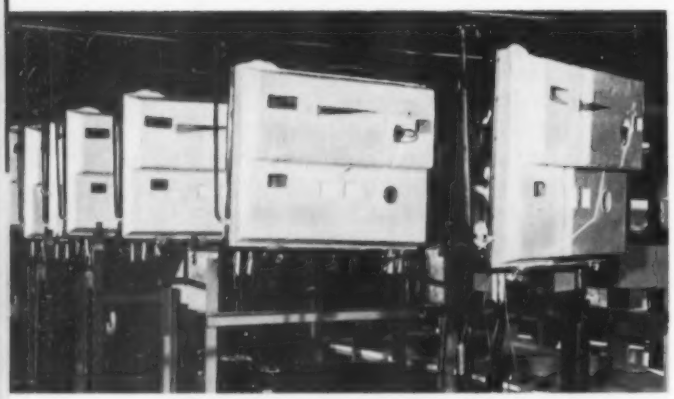


Whirlpool's system can produce urethane foams with the following range of physical properties:

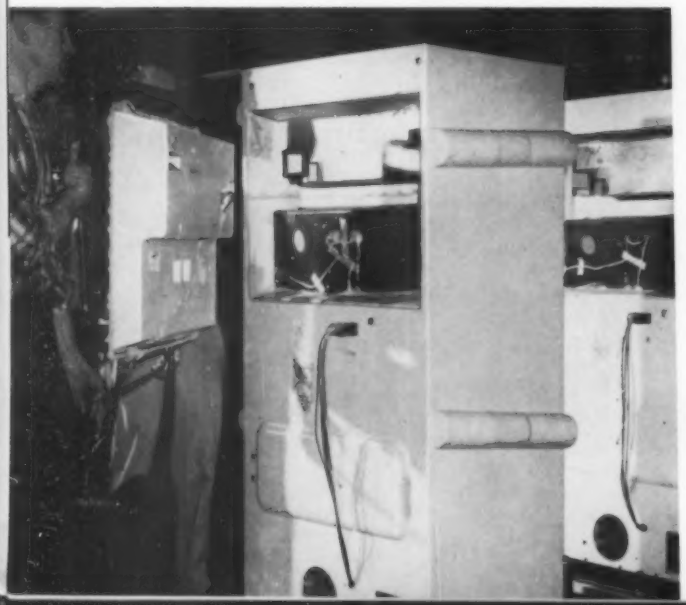
1. Density—1.8 to 2.3 lb./cu. ft.
2. Percent closed cells—90 to 95
3. Compressive strength, 77° F. (at yield)—30 to 50 lb./sq. in.
   Compressive modulus, 77° F.—1,000 to 1,700 lb./sq. in.
4. Tensile strength—70 lb./sq. in.
5. Shear strength, 77° F.—22 to 28 p.s.i.
   Shear modulus, 77° F.—300 to 500 p.s.i.
6. Thermal conductivity
   Initial K factor—0.11 to 0.13
   Equilibrium K factor—0.16 to 0.17
7. Heat distortion temp. (no load)—250 to 275° F.
8. Linear coefficient of expansion—0.000025 to 0.00003 between 0 and 75° F.
9. Moisture vapor transmission rate—1.6 to 2.5 perms/in. thickness as determined by ASTM E96-53T, Procedure E.
10. Imparts no odor or taste to food.



EVAPORATOR SECTION, locked in vertical position, has moved under dispensing station for charging. Nozzle assembly can be seen at left.



AFTER CURE in oven, molds are removed from evaporator units which then proceed along assembly line (above) to be fitted onto assembled cabinets (below). Note thin cross-section of cabinet made possible by foam insulation.



material on the inside surface of the door. As the assembly moves on, a cam arrangement automatically closes the hinged aluminum top, sealing the pre-polymer between it and the door pan.

The loaded assembly then moves through a U-shaped oven equipped with steam space heaters, where it is subjected to a temperature of approximately 150° F. for 8 to 9 minutes. During this period, the liquid pre-polymer expands and fuses into a cured foam, bonding itself permanently to the inside of the door shell. Use of a release agent on the top section of the mold prevents sticking to that surface.

After the oven cure, the only additional operations required on the doors are the installation of the vacuum-formed high-impact styrene inner door panels and the door shelf components, some of which are injection molded and others vacuum formed. With its molded shape, the foamed urethane insulation thus conforms exactly to the contour of both inner and outer faces of the door.

Although details vary, insulation of the cabinet shells is handled in substantially the same manner, with parallel conveyor lines used to facilitate preheating of the inner and outer cabinet components. After the measured volume of prepolymer has been metered into the outer cabinet shell as it lies on its back on a conveyor, it is automatically elevated until it "swallows" the steel-porcelain inner liner, which has been held in position above it. With these components locked in position with the proper spacing between them, the cabinet then moves through the curing cycle, during which the foam rises and cures to fill all the space between the two shells. An elastomeric vinyl breaker strip, used to prevent foam from overflowing the cabinet front, is removed at the end of the curing cycle. Installation of shelf supports, etc., follows.

The last component to which the urethane foam is applied is the evaporator section—the actual cooling unit in a gas refrigerator. As shown in accompanying photos, these units are placed in molds which carry them in a vertical position through the pre-heating, loading, and curing cycles. Molds are then opened and the foam-enclosed evaporators removed, ready for assembly in the back section of the refrigerator.

By giving the gas refrigerator a new lease on life, urethane foam insulation has dramatically shown its insulating efficiency and established itself as a powerful contender for use in tomorrow's refrigerators and freezers.

Credits: Dabco catalyst used in urethane foam process supplied by Houdry Process Corp., Philadelphia, Pa.—**End**

Another automotive first:

Nylon fuel regulator

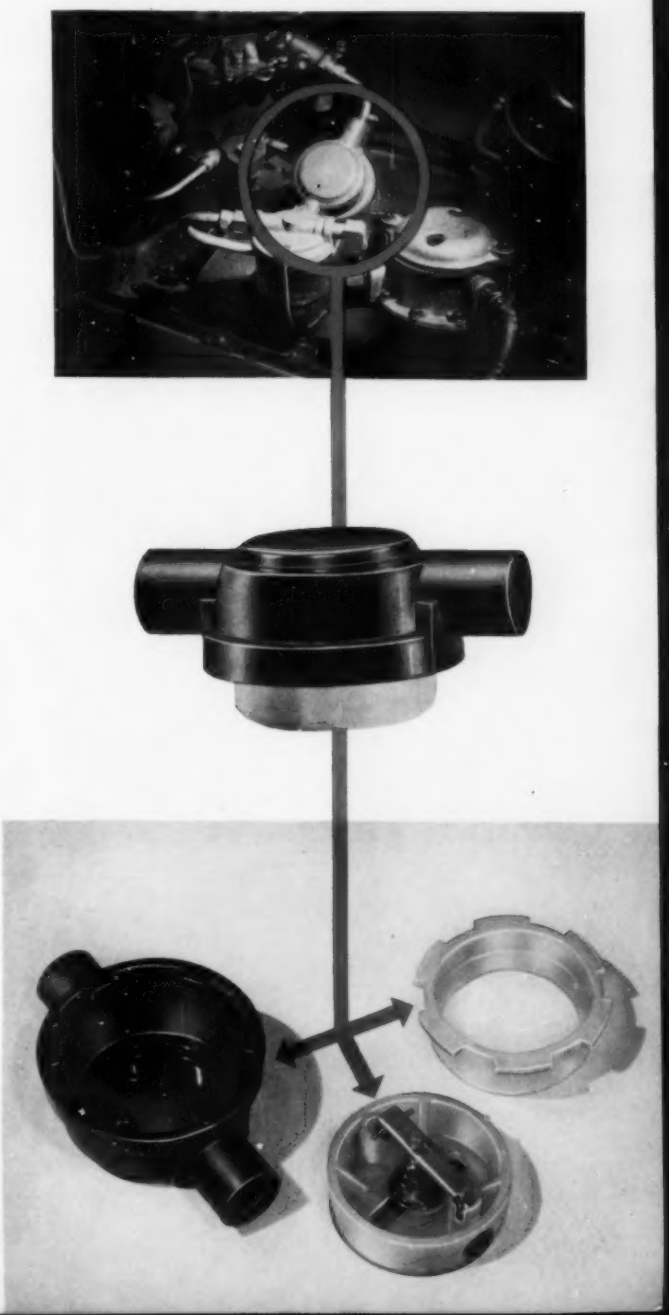
Economy of injection molding combines with nylon's resistance to gasoline and high engine temperatures to win a new automotive application for plastics

The first automotive fuel pressure regulator to be made of plastics has been developed through the precision molding of three major parts from nylon. It represents one more instance of plastics' penetration of the automotive market. In this instance, the switch to plastic design resulted in a regulator that is low in cost, light in weight (only 2 oz.), and will fit into the gas line of any automobile. Furthermore, it can be installed without adapters, parts, or fittings usually required for such installations.

The function of the Miser Mite, a product of Milemaster Inc., Exeland, Wis., is to control the pressure at which gasoline is injected into the carburetor. The device keeps pressure at a low constant, conserving fuel and promoting smoother engine performance. Operating on the ball-check principle, it incorporates a steel ball with brass seat, a reed, diaphragm, stem, three washers, and two "hairpin clips" among the working parts. A calibrated spring is used to control the pressure of the fuel at a constant 3½ p.s.i.

With the Miser Mite, it is only necessary for the installer to cut out a piece of gas line about 2⅛ in. long a short distance ahead of the carburetor. The unit, only 3⅝ in. long, is then fixed in place by inserting the ends of the opened gas line into Neoprene bushings pressed into the inlet and outlet openings. Because gasoline acts as a plasticizer for Neoprene, causing the bushing to swell, a lasting, leakproof bond is formed.

The low cost of the Miser Mite (it retails at $4.95) was made possible by the fact that precision molding of the nylon components eliminated expensive machining and finishing operations usually associated with **(To page 176)**



REGULATOR is shown installed in fuel line just ahead of carburetor intake (top) and separated into its three nylon components (marked by arrows). Color of top piece is obtained by dip dyeing immediately after injection molding.

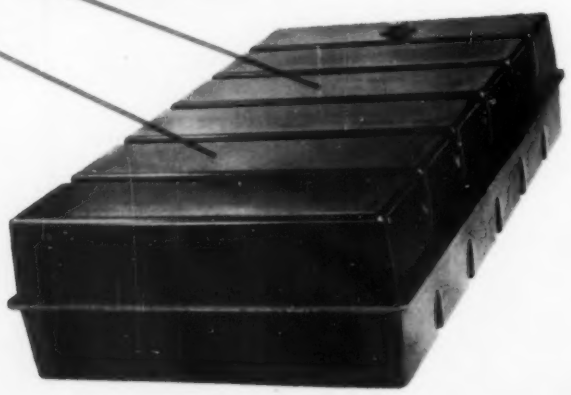
And now-pontoons of

The very properties that have brought reinforced plastics to the forefront in boat construction now have opened a new market—floating bases for marina walkways and docks

It is axiomatic in the marine industry that with salt water comes serious problems of corrosion and electrolytic decay. It is equally axiomatic that with reinforced plastics as materials of construction, the problem no longer exists.

The only surprise then about the recent introduction by two different manufacturers of reinforced plastics pontoons is that anyone has even waited this long to apply the material to this very obvious use. The market for the pontoons in floating walkways—which are beginning to supersede inconvenient and dangerous pile-supported walkways in providing access to boats—and in other marine flotation applications is a sizable one. Marine engineers in today's boat-conscious America are finding much to interest them in the success of the pontoons.

The two pontoons are made by different



MARINA at Long Beach, Calif., uses 5000 pre-formed pontoons (close-up below) to support miles of wooden floating walkways and finger slips. Glass reinforced-polyester pontoon is watertight after sealing of two molded halves with epoxy cement.

methods—each chosen to meet specific economic and design requirements. One is produced by spray-up and oven cure, the other by preform molding in matched-metal dies.

In both instances, however, similar advantages are claimed. Reinforced plastics pontoons are light in weight, they will not decay or water-log, they are unaffected by marine organisms, oil, or gasoline, they will not rust or leak, and, if it should ever be necessary, they are easy to scrape clean. Integral coloring—green for the spray-up type, natural red-brown for the preform pontoons—eliminates the painting problem that has long plagued owners of boat yards and docks.

In both instances, the manufacturers also took advantage of the design flexibility inherent in reinforced plastics to provide integral ribbing to beef up critical stress areas. This, of course, is the type of design in which the materials excel, since the addition of the ribs can be accomplished without adding much weight or cost.

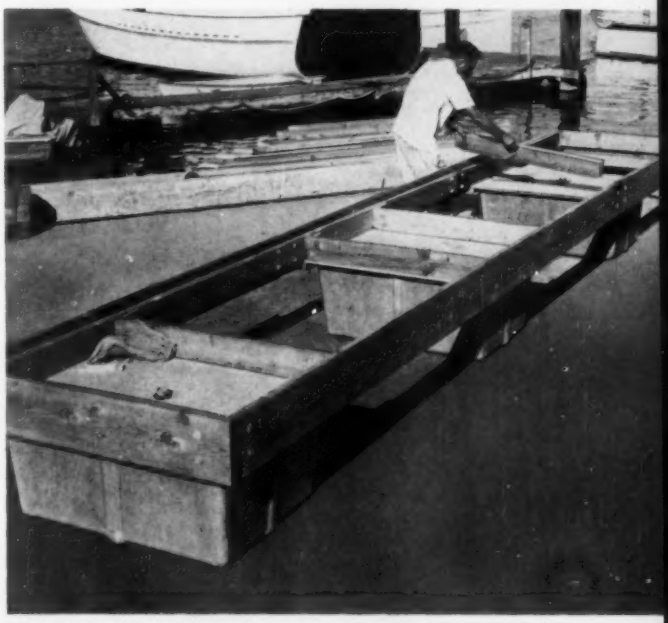
The spray-up technique

Pontoons are made by two methods: spray-up with oven cure and by preform molding. Pacific Float Co., Dillard, Ore., uses the spray-up technique for its pontoons. These are made in two sizes: 3 by 4 by 1½ ft. and 3 by 4 by 2 feet. The smaller size has a total buoyancy of 833 lb., the larger, 1050 pounds. The pontoons are three-sided tub-like structures to which a plywood board top cover is fitted. A through-fitting in the cover permits the introduction or removal of ballast so that the freeboard of the floats may be adjusted to the desired level.

In producing the reinforced plastics pontoon hulls, Pacific Float Co. uses continuous strand roving and polyester resins. Using a gun, the resin and reinforcing material are sprayed into plywood female molds. All spraying is done in a booth; the mold is mounted on a turntable so the operator can work from a stationary position and better control distribution of material.

Removed from the spray booth, the preforms are hand rolled and compacted. After this operation they are transferred via roller conveyors into curing ovens. At the end of the curing cycle, parts are removed from the mold, which is then ready for reuse. The pontoons are trimmed of edge flash at the flanged top, to which the plywood lid is later mounted. **(To page 177)**

SPRAY-UP TECHNIQUE and oven cure is used to form three-sided, tub-like pontoons in plywood mold. Mold is mounted on turntable in spray booth, so that operator can work from stationary position yet achieve even distribution of mix.



FINISHED PONTOONS, with plywood top closures affixed, are attached to pre-fab wood frame at marina site. Ballast can be added through aperture in top of the pontoons.

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Body and legs of Madame Alexander 36″ nurse doll (A) and 15″ Cathy doll (B) blow-molded of Bakelite Brand high density polyethylene for Alexander Dolls, Inc., New York, N. Y. Ring (C) and bead (D) sets and wheels for toy racer (E) blow-molded of low density polyethylene by Fisher-Price Toys, Inc., East Aurora, N. Y.

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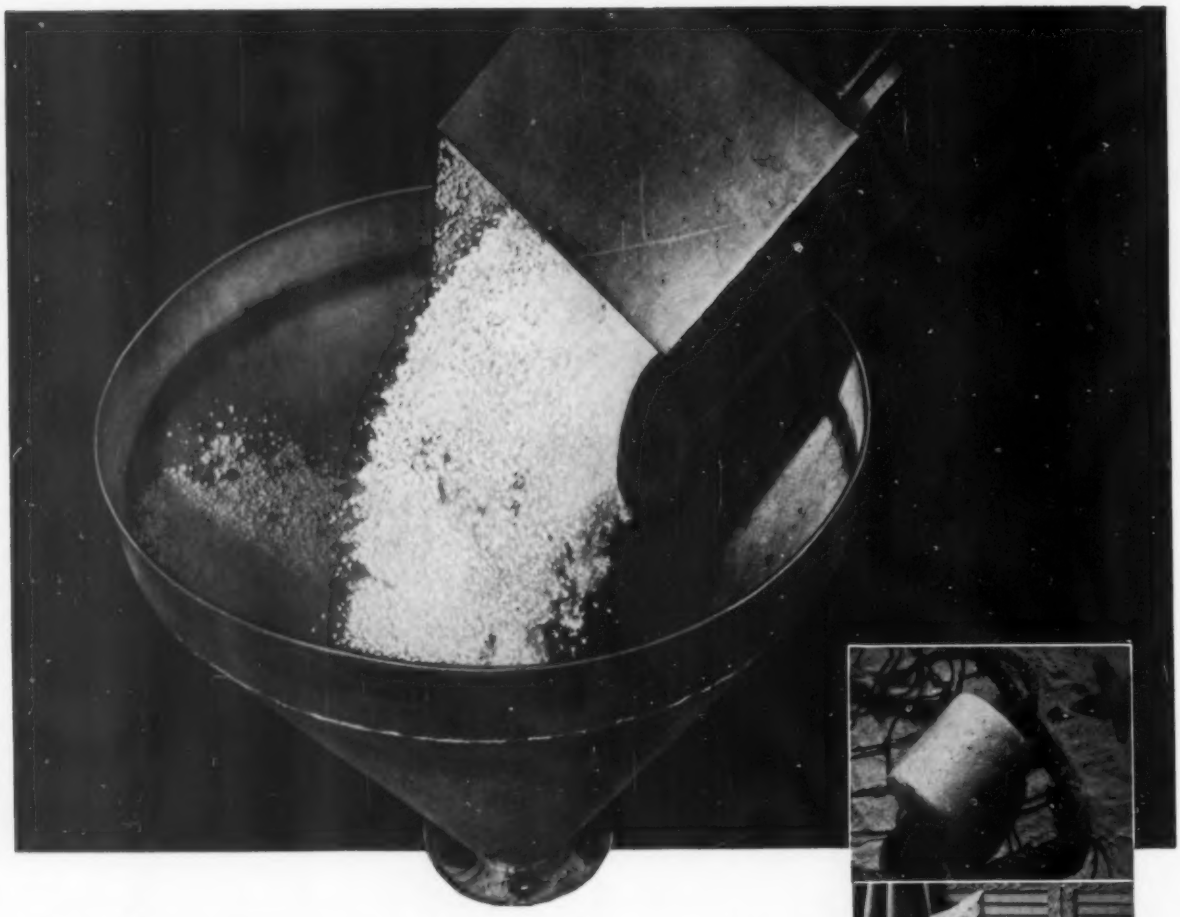

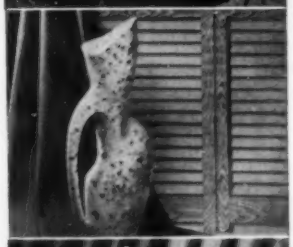

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Equipment for embedment processes

What systems are available for mixing, metering, and dispensing resins, and their advantages and disadvantages in electronic component applications

By C. A. Harper†

In controlling the cost and efficiency of processes for embedding electronic packages, proper selection of equipment is most important. The increasing use of embedding materials has resulted in rapid advances in associated processing equipment and manufacturing technology. Many of the current methods differ greatly from the older standard operations. Initially, common embedment methods involved hand-mixing and other slow operations which were of the batch type. Today, although there are few completely automated processes, there are many which are at least semi-automatic.

The major operations involved in embedding, encapsulating, or impregnating include: 1) mixing the basic resins, fillers, colors, etc., to form the compound; 2) compound storage, transfer, and evacuation; 3) proportioning the compound and catalyst, and dispensing the catalyzed compound into a mold or container housing the part to be embedded; and 4) curing the catalyzed compound.

Compound mixing or milling

There are differences of opinion as to the proper choice of compound mixing equipment. One viewpoint is that adequate mixing of resin and filler requires a milling operation. Another view is that milling is not necessary, since the resin mix desired does not require the intensive wetting of fillers required for materials which might be used for surface coatings. Both arguments have merit, and logic and economics should dictate the use of the simplest mixing operations which will give a satisfactory end-product. It is usually wise to run some tests as a guide to the choice of equipment and method. Often, simple mixing will be entirely adequate. There are cases where mechanical mixing may not be satisfactory, such as those involving hard-to-wet fillers (*e.g.*, chopped glass fibers). This type of filler may even agglomerate under simple mechanical mixing. For these cases, milling will be needed to produce a uniform compound.

Milling

Milling can be used to break down mechanically resin filler particles to improve their wettability in embedment compounds. Milling can be done on roll mills, or in ball or pebble mills. In the ball or pebble mills, grinding takes place as the balls or pebbles fall continuously through the liquid resin compound which is contained in a rotating drum. These mills come in sizes ranging from small mills of less than 1 gal. to large production mills having capacities of hundreds of gallons. Pebble mills

*Reg. U.S. Pat. Off.
†Materials and Processes Section, Westinghouse Electric Corp. Adapted from author's book, "Electronic Packaging with Resins—an Engineering and Manufacturing Guide," to be published by McGraw-Hill Book Co.

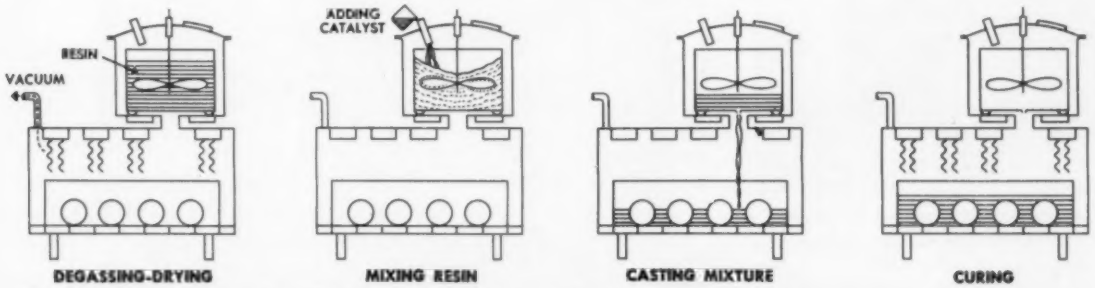

FIG. 1: Schematic diagrams showing the four steps in a vacuum potting process. Operations consist of, from left to right: degassing and drying of component to be potted, mixing resin under vacuum, casting resin, and curing the potted components.

are usually ceramic-lined and use some form of ceramic pebbles as the grinding media. Ball mills are usually metal-lined and use metal balls as the grinding media. The ceramic pebble mill is preferred for milling of embedment compounds since it reduces the risk of introducing metallic contaminants into the compound. Some contamination will always be present because of the abrasion of mill walls and grinding media. Another reason why ceramic mills are preferable to steel mills is that some resins used for making electronic embedment compounds are catalyzed to some degree by metallic contaminants. This is especially true of some polyesters. The pebble mill supplier will usually have some good ideas regarding proper choice of lining and pebbles for the pebble mill. Typical of pebbles used are French flint pebbles.

FIG. 2: Equipment for the automatic weighing of resin components. Balance is connected through control system to valve to stop flow of material when proper weight has been delivered to container below.

FIG. 3: Equipment shown measures and dispenses proportioned quantities of two components to a waiting container. Dispensed components are then mixed by hand. Dispenser is operated by turning the crank at right.

There are other important variables with regard to the use of pebble mills. One is the milling time. Many people feel that an extended grinding cycle is required for proper compounding, while others feel a grinding cycle of a few hours is adequate. Tests of electrical and physical compound properties milled for various lengths of time have shown that very long grinding cycles are not always required for electronic embedment compounds. It is desirable to keep the milling time as short as possible, since a lengthy milling cycle will increase the amount and cost of equipment required.

It is also advisable to keep cycles of ball or pebble mills short, since there is a considerable amount of mechanical heat generated in the grinding action and the temperature of the compound will gradually rise as the compound is milled. When heat-curable resins are used, temperature control is a must. Temperature can be controlled either by using a shorter milling cycle or by using water-jacketed mills. Control is extremely important; if the compound should cure in the mill, it can mean the loss of equipment and production time. Normally, volatile solvents such as acetone or others, good for polyesters, cannot be used to clean pebble mills since the mills are not designed for the high pressures which develop as the solvent vapor pressure increases during mill rotation. Frozen mills must usually be chipped out by hand, using caustic or some other non-volatile material to help loosen the compound.

Large pebble mills often are relatively expensive, since they require strong supports. Prices of pebble mill installations will vary from a few hundred dollars for a laboratory installation to several thousand dollars for a full-scale installation. Therefore, such installations necessarily add to the processing cost and cycle time. Nevertheless, for certain operations, compound milling of formulations is an extremely necessary and/or efficient process.

Mechanical mixing

For most compounds, a study of the physical and electrical properties of compounds mixed mechanically indicates that mechanical mixing is most adequate. In addition, mechanical mixing is usually more controllable, less costly, and more versatile. Thus, it is not surprising to find that mechanical mixing is used more widely than milling operations.

Mechanical mixing equipment usually consists of a heated tank for handling high-viscosity compounds, a variable-speed mixer drive and impeller (usually air driven), and perhaps a vacuum attachment to remove air from the mixed compound. Air-drive mixers are safer than electrical mixers for use with synthetic resins. Also, air mixers usually cost less and have better speed control. Although mixing is basically a simple operation, attention to details will produce better results and eliminate many troubles.

Since a stirrer will be inserted into the mixing tank, the tank should be externally heated using blanket heaters or a hot-water jacket. Wrap-around heaters usually provide sufficiently uniform heat, but they can develop hot spots. Electrical strip heaters should not be used since they are even more prone to development of hot spots. The jacketed tank is the best method. Experience indicates this method provides very controllable and uniform compound temperatures. If a jacketed tank is used, the inner and outer shells should be rigidly fixed to one another to prevent movement of the inner tank and the scraping of the inner tank surface by the metal mixing blades. This may occur in cases of misalignment of the inner shell and mixer shaft. Such scraping can lead to wear and puncture of the inner tank, and allow

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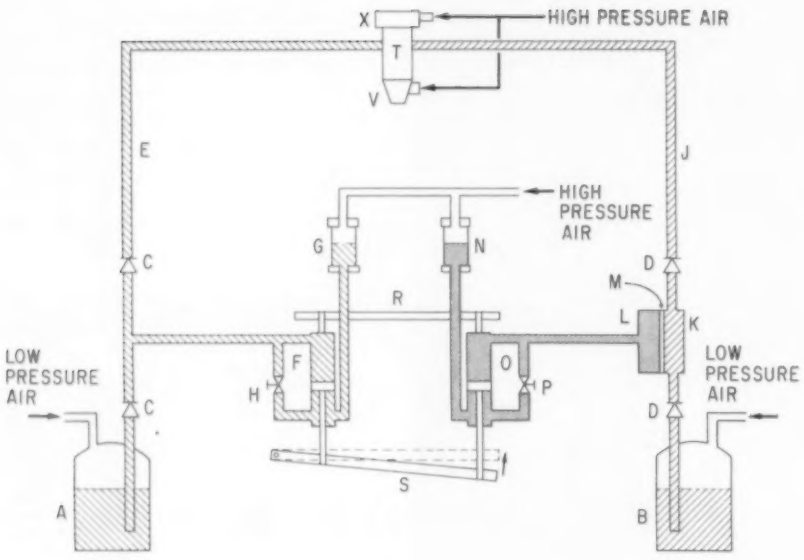

FIG. 4: Automatic Process Control Co. system for the automatic metering, mixing, and dispensing of catalyzed resins. For detailed description of the system's operation, see the text, p. 178.

the heating medium to contaminate the compound. Uniformity of compound temperature is especially important for polyester resins which may polymerize by overheating. Uniformity is not as critical for epoxy resins.

It is wise to have a variable-speed mixer if the mixing tank also serves as a storage tank. High speed may be needed to disperse the filler in the resin, while low speed is usually adequate to keep the filler from settling in the resin. Low-speed agitation is preferable for resin storage, since high-speed agitation tends to trap air in the compound. Many types of mixing blades can be used. However, there is some tendency for fillers to agglomerate on the inside surfaces of the mixing and/or storage tank. Thus, paddles with flexible tips which continuously scrape the inside surface of the tank are desirable. Since fillers do not flow as easily as resins, it is important that the top of the mixing tank be easily removable or have a fairly large feed port. Otherwise, charging the filler to the tank may be difficult. To prevent dusting of the filler while charging, it may be necessary to have either a hood over the mixing tank or to use a vibratory type funnel to feed the filler to the mixing tank. It is also helpful to have a calibrated liquid level gage, to check the depth of compound in the tank. Control of liquid level is important, especially if the mixing tank is also used for evacuation and storage and is connected integrally to an automatic metering and mixing machine.

If air in the compound is to be evacuated in the mixing tank, then the level of the compound must be kept low enough to allow space for the foam head to rise and break under the vacuum. If the compound level is too high, the foam will not break and air in the compound will not be completely removed. Therefore, the tank should have the largest possible diameter combined with the smallest possible height, since the depth of foam formed will depend more on the height of the compound in the tank than the area of the liquid surface. Since it is desirable to know when the foam head has broken, two sight windows should be installed in the top of the tank. One window will be needed to illuminate the interior of the tank; the other will be needed for actual observation of the foam. If desired, one can have the mixing tank and the storage tank as separate items. But one tank will usually suffice and reduce equipment cost and space needs.

Also to be considered is the material of which the tank is constructed. The inside surface should resist corrosion and have the minimum possible tendency for adhesion of agglomerates. A stainless steel or plastic lining, such as polyethylene, can be used. A smooth surface is important in mixing polyesters not only from the corrosion and filler agglomeration aspects, but also because polyester resins tend to build up on the walls of the container. Since tanks containing polyester resins must be cleaned at regular intervals, it is wise to minimize cleaning and maintenance costs as much as possible by using either a very smooth interior surface or even perhaps a removable container.

Compound transfer

After the compound has been mixed, it usually must be transferred to other operations in the process. Although pumps of various types can be used, their use often has draw-backs. With filled compounds, pumps can wear rapidly due to the abrasive action of fillers such as silica. Also, uncatalyzed compounds which react under exposure to air or heat will tend to gum up the pumps. However, unfilled resins do not usually gum up pumps, and pumping is satisfactory. In most cases, the best way for transferring material is by the use of pressure. This requires pressure-type tanks, but it does eliminate the problems common to pumps. Pumps can be used with epoxy resins, since epoxies do not gum up as readily as polyesters. Transfer distances should be as short as possible, since pipe lines will also gum up; so will storage tanks. Thus, the same considerations which apply to storage tank inner surfaces—resistance to corrosion and agglomeration plus a smooth surface—also apply to

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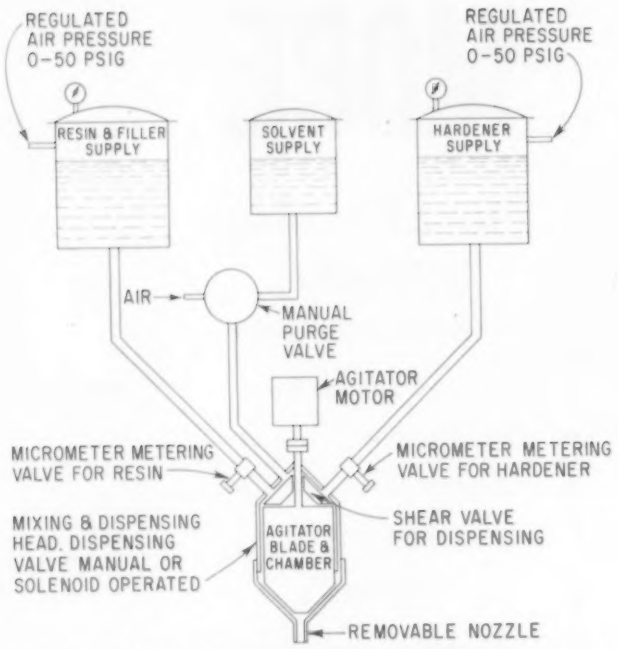

FIG. 5: Hull-Standard Corp. system for automatically metering, mixing, and dispensing catalyzed resins and compounds. System uses micrometer flow valves to control the resin component streams. Full description will be found in text, p. 178.

transfer lines, with the added condition that the transfer line should be as short as possible.

Equipment for vacuum embedding

In the embedment of electronic assemblies, it is always desirable, and often mandatory, to exclude all air from the embedment compound before using it. One reason is that entrapped air has a low dielectric strength and is a potential point of electrical failure for high-voltage applications. Another reason is that entrapped air can cause surface cavities or voids in the finished parts which spoil the appearance and require costly repairs.

The essential steps in vacuum embedding are shown in Fig. 1, p. 105. (1)[1]. In such equipment, the resin is placed in the top container and the parts are placed in the bottom chamber. The doors and lids are sealed and a vacuum is applied to the system. The evacuation rate on the upper chamber is controlled by an operator who monitors the degassing process through a sight glass in the top. When bubbling stops, the operator can assume that the resin is completely free of occluded air. Care must be taken in regulating vacuum so that the resin itself does not begin to boil.

During degassing, the lower chamber is also evacuated, and the items to be embedded are generally heated to about 150 to 200° F., to drive off the moisture and other volatiles in the parts. Time for part degassing and drying is usually 10 to 40 min., depending on mass of mold, temperature required, nature of volatiles, etc. When the components are up to temperature, and the resin mixture has stopped bubbling, the resin is allowed to flow down into the potting chamber where it is channeled to fill each mold in turn. A turn-table is cycled so that each component receives its charge of mixture. Resin flow can be stopped by plugging the top container, but parts are usually arranged so that they can be moved under a continuous resin stream.

As soon as embedment is complete, the upper tank is plugged to stop the resin flow and the chamber is allowed to return to atmospheric pressure. The potted components may remain in the chamber under heat for a period of time or they may be transferred to an oven for further cure of the resin. After the parts are removed, and the upper disposable container removed, the unit is ready for the next cycle.

Another commercial unit, similar in principle but of a different design, is made by Red Point Products Inc., Glendale, Calif. In this equipment, the catalyzed compound is loaded into separate cups above molds containing the individual parts to be embedded under vacuum. Both the cups of catalyzed compound and the parts to be embedded are positioned in a common vacuum chamber; the same vacuum and temperature is applied to all components in this system. After the air has been evacuated and the system is at the proper temperature, resin container valves are opened allowing the catalyzed resin to flow into molds holding the assembly to be potted.

Automatic metering, mixing, and dispensing machines

The widespread use of embedding and impregnation materials and processes has resulted in the development of machines for continuously proportioning, mixing, and dispensing polymerizable liquid resin-hardener systems. These machines have several advantages over manual methods. First, they are more economical. Hand mixing is slow, costly, and messy. It is also unsafe and unhealthy. Furthermore, hand mixing can result in qualitative variations due to differences in operator technique. In addition to overcoming the disadvantages, automatic metering, mixing, and dispensing systems help overcome the problem of resin pot life.

For manufacturing efficiency, short curing cycles are desired. Short curing cycles usually require resins with short pot life. In hand mixing, the entire batch of resin to be used is usually catalyzed prior to being dispensed. Because pot life is short, many small individual batches must be made. In most machines, the compound and catalyst are not mixed until actually needed. Thus, a compound with short pot life can be handled faster, more efficiently, and at less cost than by hand mixing.

Design of a system entirely satisfactory is not easy, and no one machine will be satisfactory for all applications. This is due to the variations in resin properties, com-

[1]Numbers in parentheses refer to references at end of article, p. 187.

WHAT'S NEWS IN ENJAY TECHNICAL SERVICE

Enjay helps reduce cost of 90°C vinyl wire insulation...

An important part of Enjay Technical Service is developing useful new products that reduce costs, yet maintain performance. Ditridecyl phthalate for use in plasticizing vinyl wire insulation is a good example of this research activity. By tests, such as the oven aging shown above, Enjay was able to prove that DTDP, made from Enjay tridecyl alcohol, performs as an efficient, non-volatile plasticizer for 90°C wire — yet reduces plasticizer cost. Test results, at right, show that the insulation exceeds the U.L. Specifications.

Enjay research facilities and technical skills are available to customers in the vinyl wire, film and sheeting industries.

If you would like to receive a free copy of our new Technical Bulletin No. 20 on Enjay oxo alcohol for plasticizers, write to 15 West 51st Street, New York 19, N. Y.

TEST RESULTS: 7 DAYS @ 121°C

	U.L. Specification Minimum	DTDP Plasticizer
Elongation	65% retention	100% retention
Tensile Strength	65% retention	101% retention
Dielectric Strength	50% retention	127% retention
Insulation Resistance*	.01 megohm based on 1000 ft.	0.36 megohm based on 1000 ft.

* 1 day and 7 days @ 113°C.

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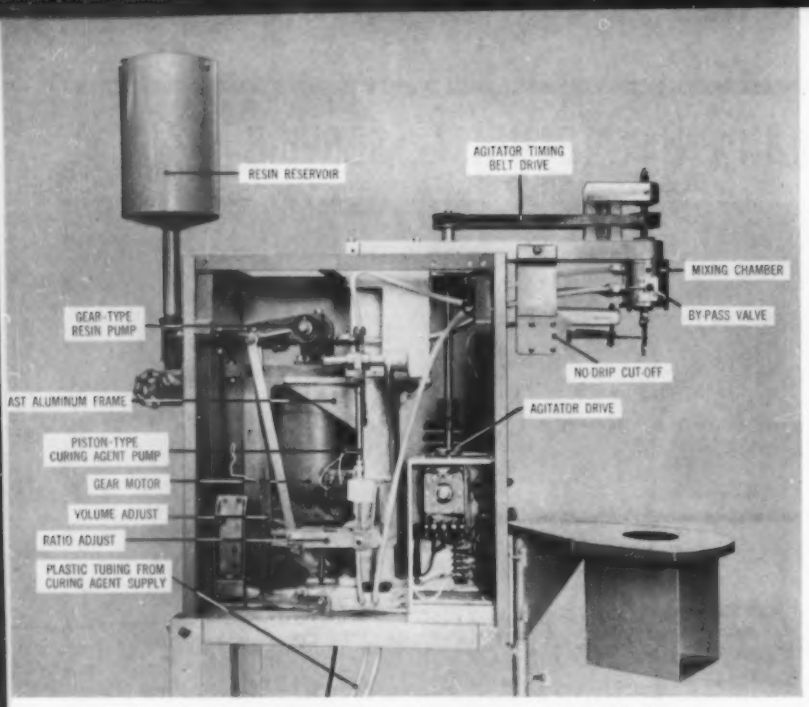


FIG. 6: H. V. Hardman Co. automatic metering, mixing, and dispensing machine uses gear pumps for shot volume metering and control.

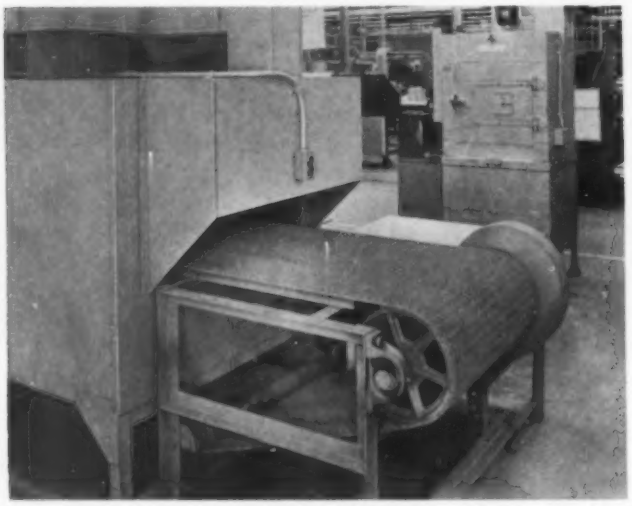


FIG. 7: Typical conveyorized oven installation used for the curing of electronic embedments. Note the open mesh conveyor belt which is preferred because it affords more uniform heat exposure of the parts.

pound formulae, temperature requirements, and many other variables, including the production rate and degree of evacuation required by the compound. However, several machines are available which are adequate for most applications.

Gammel has reported detailed studies of these systems (2) and provides a list of suppliers of metering, mixing, and dispensing equipment. Equipment is available in a wide range of capabilities with respect to all of the material and processing variables which are likely to be encountered in embedment resin systems. The degree of automation available varies from units with only simple weighing controls to almost completely automated units which control mixing, evacuation, metering, dispensing, purging, shot size, and shot frequency. Costs vary from a few hundred to over $10,000.

Machine designs vary considerably. Some machines use pumps for material proportioning and transfer, some use pressurized feed with proportioning cylinders, and others use pressurized feed through a preset orifice. These are probably not all the material feed and proportioning systems in use, but these are the most common. The basic principles of operation of some of the commercially available systems are described below.

Automatic batch weighing

The first improvement over a hand operation is the use of automatic component weighing. Fig. 2, p. 106, shows a balance modified for controlled batch-weighing and dispensing of liquid components. In use, it is only necessary to set the scale for the weight of liquid required, press a button, and an electrical control valve dispenses the liquid, stopping the flow when the proper amount has been dispensed. This system can be designed with multiple valves for batch weighing of several components.

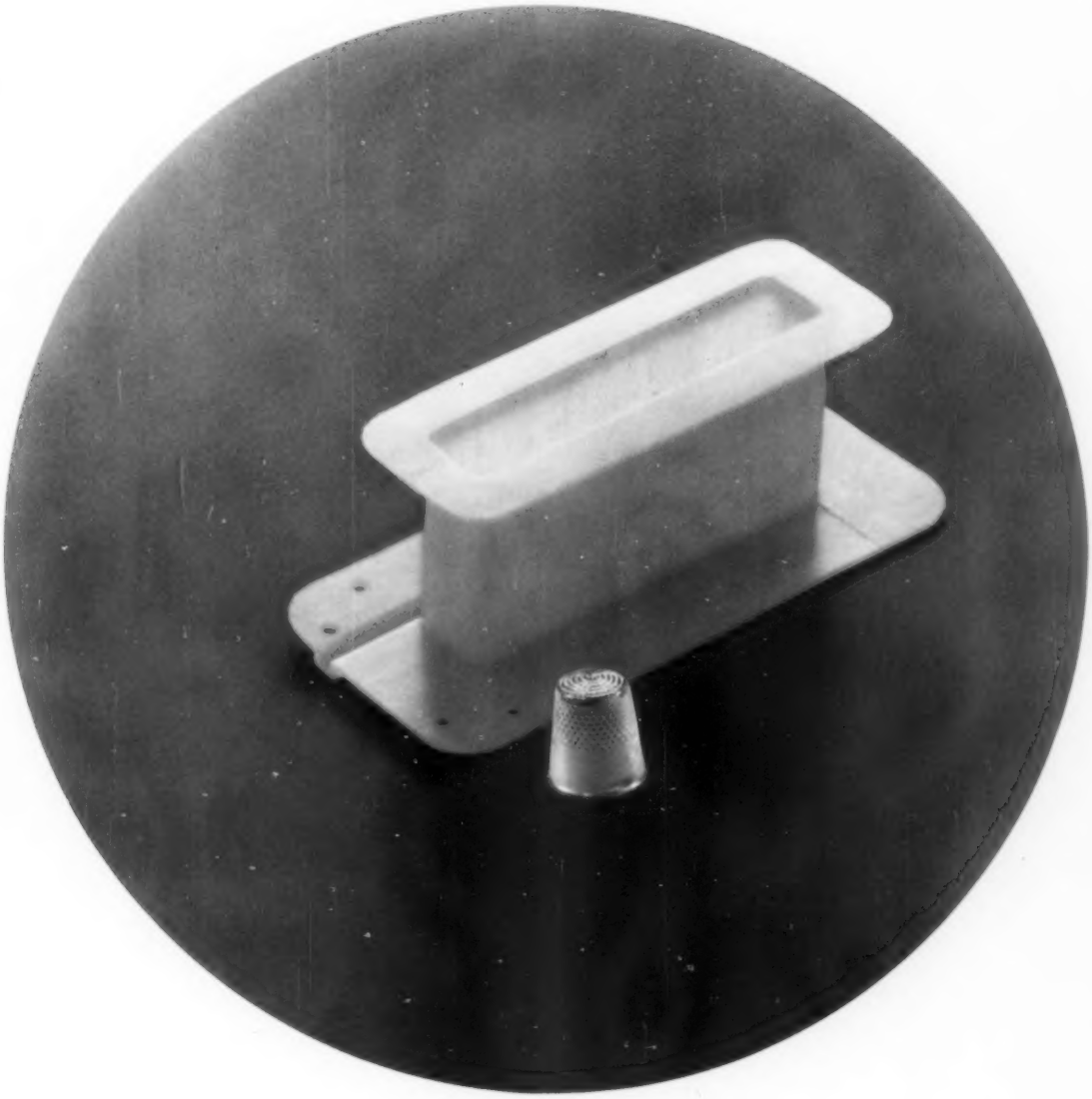
Automatic weighing and dispensing

An extension of the automatic weighing described above is the Delsen equipment (3) shown in Fig. 3, p. 106, which combines weighing, dispensing, and proportioning functions. However, this unit still does not incorporate mixing the catalyzed compound. Individualized resin components are simply dispensed by hand-cranked or motor-driven pumps. Fixed or variable two-component proportioning systems with ratios of 100:5 to 100:50 are available.

Automatic proportioning, mixing, and dispensing systems

Numerous systems are completely or partially automated. These systems proportion the resin and curing agent components, mix these components, and continuously dispense the catalyzed compound in definite shot sizes and at preset shot and resin flow rates. In most cases both shot size and flow rate are variable. Most systems include some form of purging and/or timing system to prevent equipment freeze-up and to allow for cleaning operations. Also available are a variety of heating or cooling, storage and mixing **(To page 178)**

Plaskon NYLON 6, GLASS-FILLED, TAKES HEAT, STRESS



Bobbins made of Plaskon Nylon 6 reinforced with glass fiber (shown above with thimble for size comparison) contribute to a better exciter generator, reports Electric Machinery Mfg. Co. of Minneapolis, Minn. The manufacturer says: "The molded bobbins are a **durable** and **economical** means of providing the field winding in one unit for insertion on the pole."

Glass fiber reinforced Nylon 6 has greatly improved dimensional stability, excellent moisture resistance and extremely high heat resistance — permitting intermittent use above 400 degrees F. Tensile strength is high (30,000 psi), as is resistance to distortion caused by winding.

The molding compound used in this bobbin, Nylafil G3, consists of Plaskon Nylon formulated with glass filler in a rigidly controlled process by Fiberfil, Inc., Warsaw, Ind.

PLASKON NYLON 6 OFFERS:

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- rigidity
- light weight
- lower shrinkage
- greater impact strength
- easier colorability
- moisture resistance
- abrasion resistance
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Efficient both electrically and economically, this Plaskon Wood-Flour Filled Urea circuit breaker case delivers superior arc resistance . . . 80-100 seconds (ASTM). The maker states that its dielectric and insulating properties have proven satisfactory in this circuit breaker case, as well as other cases in his line.

Allied Chemical Corporation developed this material specifically for high-speed automatic molding of electrical parts; Plaskon Wood-Flour Filled Urea is now thoroughly proven in the field. It matches or exceeds the more expensive alpha-cellulose urea in all properties except translucency and color range. Available in NEMA brown or standard black.

Other important properties of Plaskon Wood-Flour Filled Urea: Superior color-fastness • Impervious to household solvents • Non-electrostatic surface.

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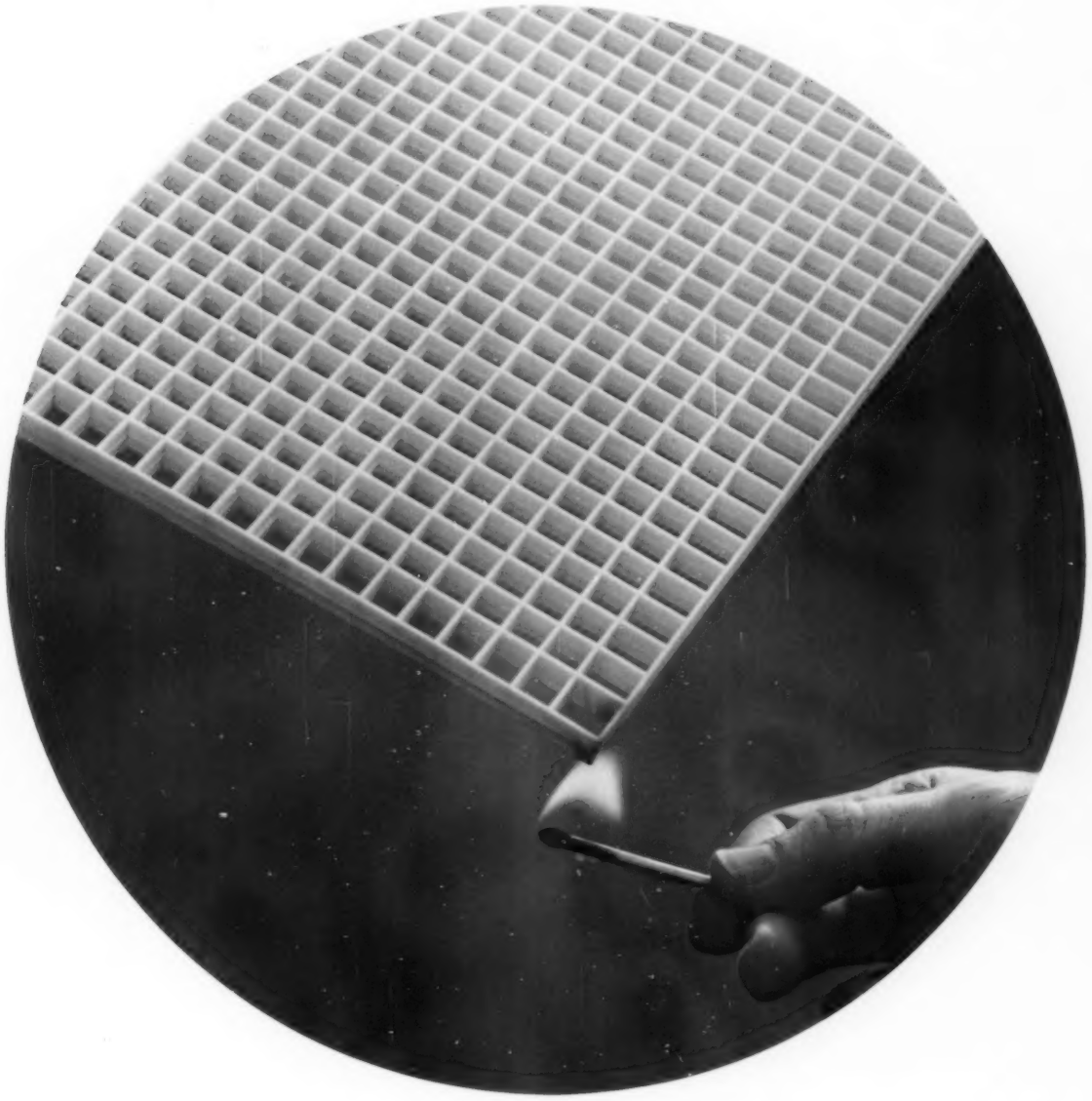

Lighting grids like this made of Plaskon Fire-Resistant Urea UFR-28 stand up well to flame!

Where the UL fire tunnel test may cause other white and pastel materials to blister, drip or contribute readily to flame spread, this grid has a low UL flame spread rating of 25 . . . considered "Non-Combustible" in general practice! In addition, its ASTM rating is "Non-Burning."

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Other important properties of Plaskon Fire-Resistant Urea UFR-28 . . . high dielectric strength; rigid enough to support itself; hard surface resists scratching and abrasion and facilitates cleanup; colors are spectro-photometrically controlled for precise lighting values.

Look to Allied for Urea Molding Compounds when you need good fire resistant and electrical properties, rigidity, strength, wide color range, or combinations of these. Plaskon materials and know-how to help solve your problems are freely available. We'd like to hear from you.

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1. Plaskon Alkyds provide high arc and insulation resistance. A three kilovolt potential between base pins presented no problem.
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3. In this application, a maximum bulb temperature of 250° C (482° F) has no adverse effect on the Plaskon Alkyd base.
4. The fast cure rate, dimensional stability and uniformity of Plaskon Alkyd permit high-speed, high-precision parts production.

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How to determine resin cure

A new, quick and easy method for determining the degree of cure in phenolic resin-impregnated materials

By John C. H. Chang*

In plastics plants which process preimpregnated phenolic materials (phenolic prepregs), the resin content, the degree of cure, and the volatile content of the prepreg are often measured to determine the quality and uniformity of the incoming raw material. For many applications it is very important that the prepreg fed to the process be consistent and uniform in quality to guarantee the reproducibility of satisfactory physical properties in the finished product. In connection with these quality control tests, it has been found that using accepted test methods for certain of the above prepreg properties produces data which have little real significance. While test methods for resin content and volatile content are relatively cut and dried and if the tests are conducted with a reasonable degree of precision, accurate and reproducible results are usually obtainable; however, conventional tests for determining the degree of cure that exists in the prepreg, as received, prior to processing produce results that are of dubious value.

Because of the poor quality-control, results obtained through use of conventional test methods for the degree of cure in phenolic prepregs, a developmental program was undertaken to find a better test for this important property. This article describes the thinking that went into the development of the new test method and the method which evolved from the test program.

In outlining the experimental program, it was decided that the test method to be developed, if it were to be an efficient tool for quality control, should have the following attributes:

1) The method should accurately indicate the value of the property being measured.

2) The results should not be materially affected by variations in other properties of the prepreg.

3) The results should be reproducible with a high degree of precision and accuracy. Equally important, the test method should be easy to perform and capable of being completed in a short time, so the test can be used in production for quick quality checks.

Is resin flow a criterion?

Conventionally, it has been felt that resin flow is directly proportional to the degree of cure and, therefore, determination of the resin flow will yield a number indicative of the degree of cure.

Resin flow has also been widely used as a measure of cure because of the ease and rapidity of the test. However, values of resin flow are greatly affected by resin content. Other properties such as volatile content, glass weight, and so forth can also affect the resin flow. Thus, although two identical materials might have the same resin-flow value, they may not have the same degree of cure. **(To page 120)**

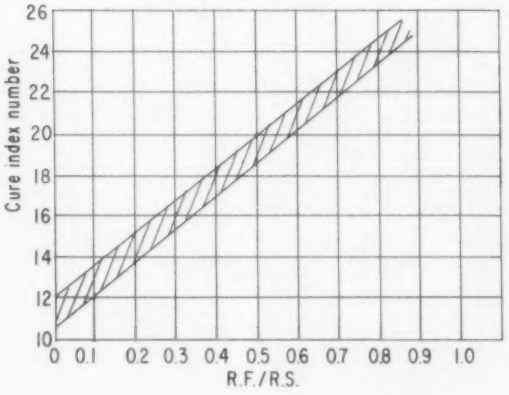

FIG. 1: Cure index number plotted as a function of the ratio of percent resin flow to percent resin solids content.

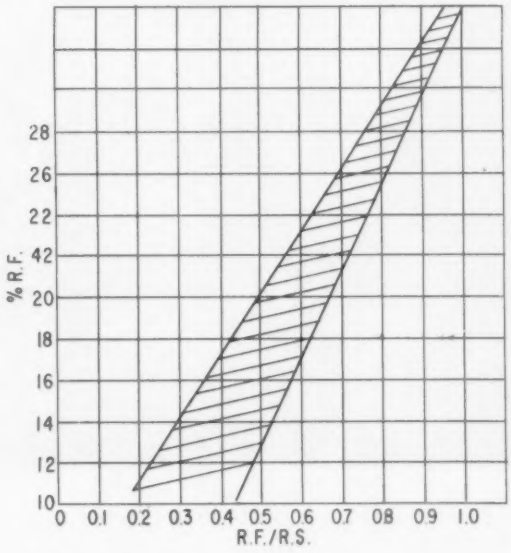

FIG. 2: Resin flow in percent correlated with the ratio of percent resin flow to percent resin solids content. Correlation is not as good as that in Fig. 1.

*Technical Director, American Reinforced Plastics Co., Los Angeles, Calif.

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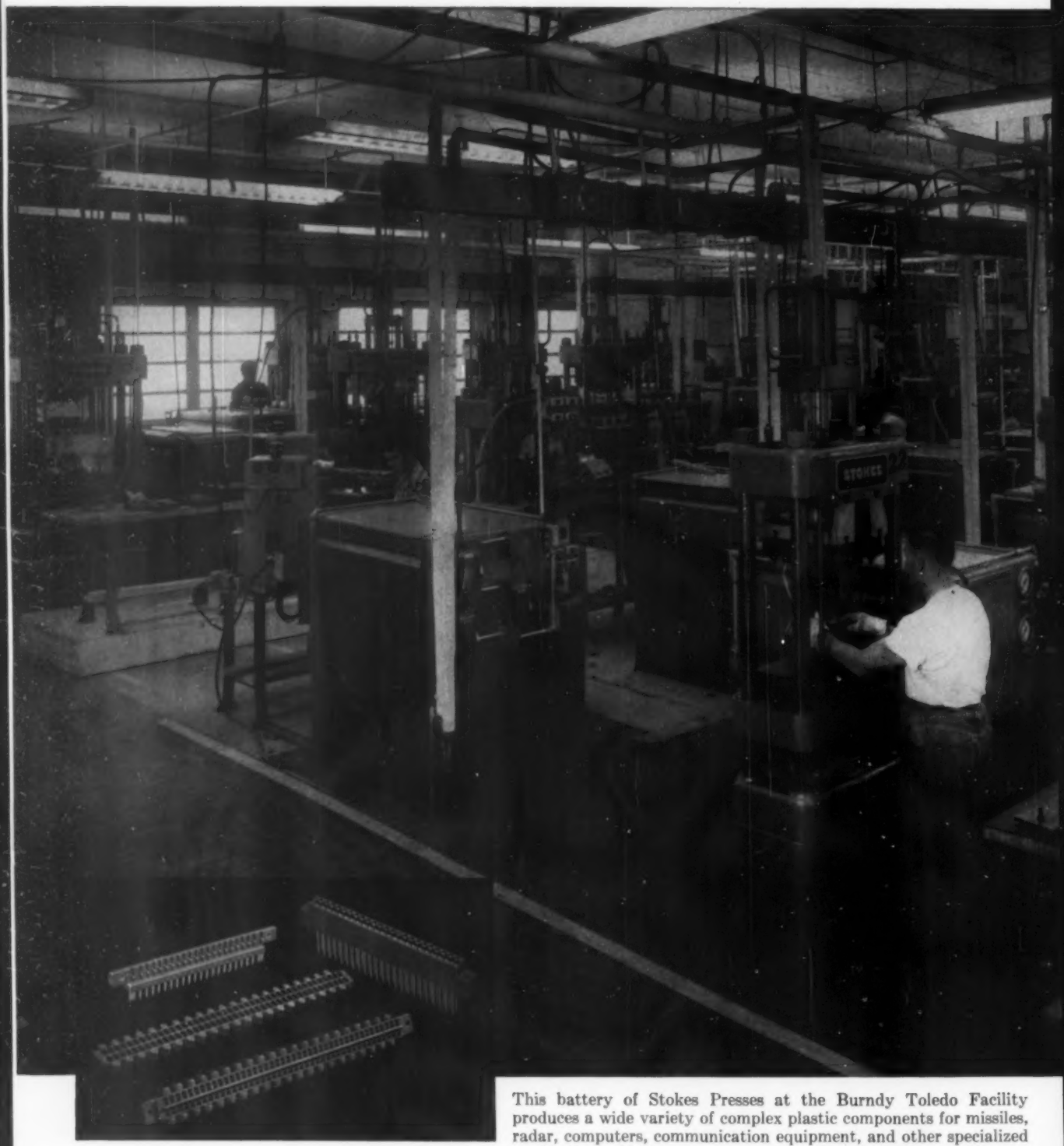

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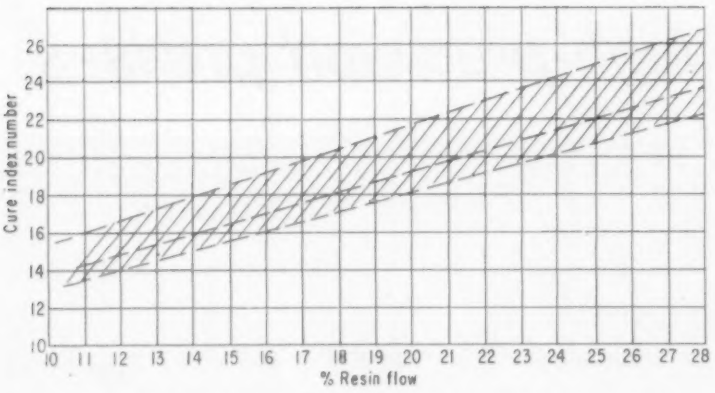


FIG. 3: Cure index number correlated with percent resin flow parameter.

One material which has higher resin content and higher degree of cure could quite possibly have the same resin flow as another one with less resin content and a smaller degree of cure. It is, therefore, meaningless to use resin flow as an indication of the degree of cure. Test methods based on resin flow, therefore, do not fulfill the first two requirements of the test method desired as outlined above.

What test method should be used? There are many which could be used that are accurate, meaningful, and independent, but they require excessive time to perform. It was, therefore, necessary to devise a new test method which would either determine the degree of cure directly or an index which is independently and directly proportional to the degree of advancement of the cure.

It was well known that the solubility of a polymer in a solvent is proportional to the molecular weight, which is in turn proportional to the degree of cure. The method of determining the degree of cure by the "acetone number" or "resin greenness" is based on the above principle. However, this method requires extraction of all the resin from the prepreg, otherwise erroneous results will be obtained.

It was often found that it is extremely difficult to extract all resin from a phenolic prepreg with a high degree of cure. Then further experimentation disclosed that only a small amount of resin need be extracted in order to determine a numerical index value indicative of the resin's cure from the extract when the extraction is conducted as follows:

1. Mix about 50 cc. of acetone with about 15 g. of prepreg and agitate for about 1 minute. Decant the solution to another stoppered flask. If the solution is cloudy, decant through filter paper.

2. Pour small amount of solution to an evaporating dish and determine the percentage of resin solids (% R. S.) by drying at 275° F. for about 5 minutes. If the % R. S. is lower than 4%, discard the solution prepared, and prepare another solution by mixing the resin prepreg and acetone for a longer time or use a larger sample.

3. Perform the following calculation to determine the amount of acetone to be added to the solution to adjust the % R. S. to exactly 4 percent.

Grams of solution to be used = W_1 or 80/% R. S.
Wt. of acetone to be used = W_a or 20 $-W_1$

4. Weigh out W_1 of solution, mix with W_a of acetone. This adjusts the extract to a 4% solids concentration.

5. Pour 25 cc. of the adjusted solution into a flask and titrate with distilled water to a persistent, cloudy end point. The number of cc. of water used equals the index number indicative of cure.

The determination usually does not take over 15 minutes.

The index number so obtained, as explained previously, will depend on the solubility of the resin in an acetone water mixture. High molecular weight resins (*e.g.*, resins in which cure is well advanced) exhibit a lower solubility in solutions of acetone and water and will exhibit a cloud point with a lesser amount of water in the solution than will greener resins with a lower degree of cure. Thus, the number so determined will vary inversely with the degree of cure in the prepreg, a lower number indicating a higher degree of cure.

As can be realized, the presence of non-volatile ex- **(To page 190)**

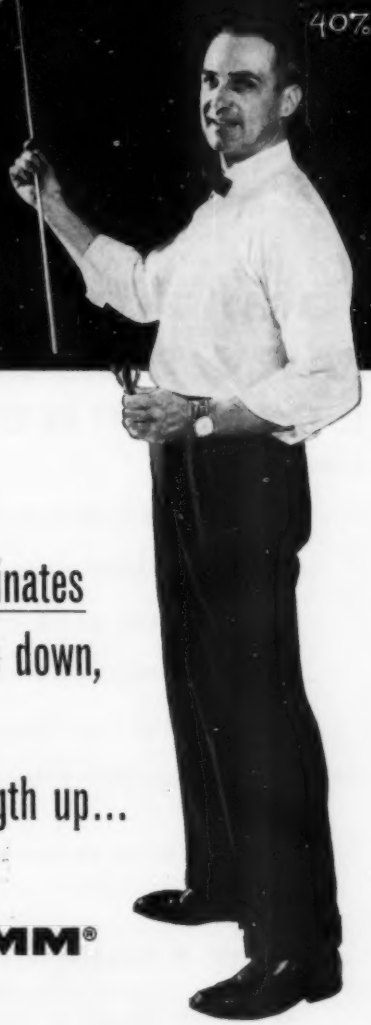
Correlation of Chang's Index Number[a] values with other property test data on Adlock 851 prepreg material

Resin content	*Volatile content*	*Resin solids*	*Resin flow*	*Chang's index*	*Ratio of resin flow to resin solids*
%	%	%	%		
43.6	9.73	33.9	29.2	25.3	0.86
41.8	9.08	32.7	29.2	24.7	0.89
39.5	8.24	31.3	23.4	23.9	0.75
46.5	9.70	36.8	27.6	23.7	0.75
42.0	9.45	32.6	23.6	23.6	0.73
40.7	8.18	32.5	23.3	23.3	0.72
41.2	8.00	33.2	23.0	23.3	0.69
43.3	8.74	34.6	24.9	21.8	0.72
45.5	8.77	36.7	26.1	21.4	0.71
40.5	4.26	36.2	16.7	20.0	0.51
45.8	5.96	39.8	22.0	19.3	0.55
41.1	3.36	37.7	18.3	18.2	0.44
40.2	3.53	36.7	11.8	16.6	0.32
42.8	2.93	39.9	11.3	15.8	0.46
41.2	3.37	37.8	8.6	15.6	0.23
42.7	3.09	39.6	12.0	14.9	0.30

[a]Appropriately, the new index number, which is indicative of resin cure, has been designated Chang's Index Number in the author's honor.

Physical Properties of Polyester Laminate

	28.5% Surfex MM	40% Surfex MM	50% Surfex MM	60% Surfex MM
Specific Gravity	1.76	1.80	1.87	1.95
Izod Impact, Ft. Lbs./In. Notch	14.4	16.2	17.3	16.5
Tensile Strength, psi	20,300	21,300	20,100	19,300
% Elongation	1.89	1.92	1.94	1.87
Modulus of Elasticity in Tension, psi x 10⁶	1.15	1.36	1.45	1.85
Flexural Strength, psi	33,150	33,600	37,800	37,000
Modulus of Elasticity in Flexure, psi x 10⁶	1.08	1.18	1.44	1.20
Barcol Hardness (10 sec. Reading)	55	57	62	66
Initial Viscosity of Mix	1,200	2,100	3,200	5,000
Fiber Glass Mat	40%	40%	33%	33%



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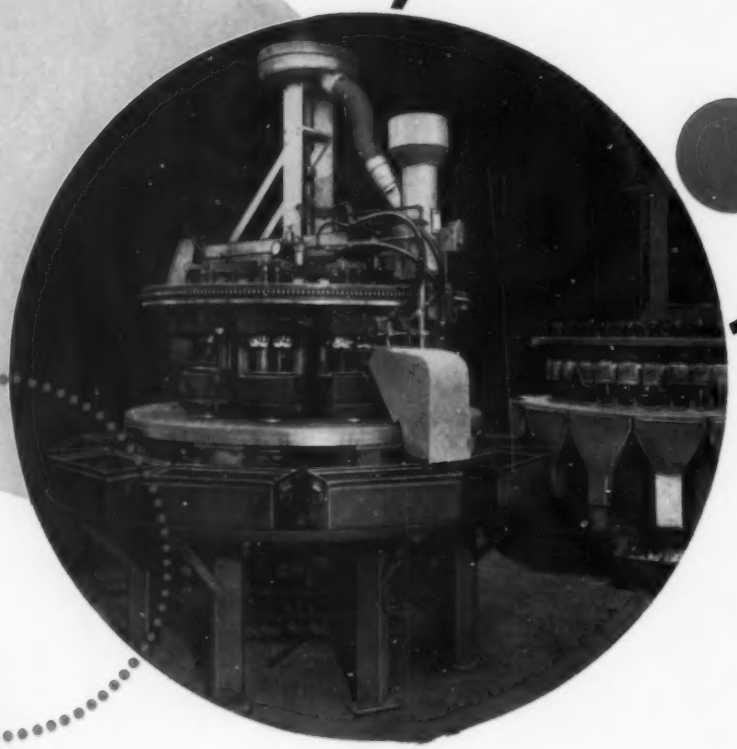

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PLASTICS* TECHNICAL SECTION

MATERIALS • PROPERTIES • TESTING METHODS AND INSTRUMENTATION • STANDARDS • CHEMISTRY

Adsorption of polymers on glass and other substrates—Part I

By R. R. Stromberg† and G. M. Kline†

The nature of the attractive forces between resins on the one hand and glass fibers or fiber finishes on the other must be determined in order to understand the reinforcement mechanism and thus be in a position to make rational selections of the components of reinforced plastics. One means of studying these forces is through investigation of the adsorption of polymers. The following factors are considered in an exploration of the adsorption behavior of polymers onto glass, silica, alumina, and other adsorbents: 1) rate of adsorption, 2) nature of adsorbent surface, 3) effect of solvent, 4) molecular weight of polymer, 5) temperature, 6) adsorption-desorption reversibility, and 7) configuration of the adsorbate molecule. The nature and adsorbability of the end groups and the monomeric units recurring along the chain, together with inter- and intramolecular interactions, lead to complex phenomena in polymer-solvent-adsorbent systems. The applicability of several equations, including those proposed by 1) Langmuir, 2) Simha-Frisch-Eirich, and 3) Gilliland-Gutoff, to account for the adsorption behavior of polymers is considered. The conclusions that can be drawn from these theoretical expressions regarding the effects of various parameters on the adsorption of polymers are reviewed.

Part I covers Factors 1 through 4 enumerated above; the remainder will be covered in Part II, which will appear in a forthcoming issue.

The increased applications of and demands for reinforced plastics have led to requirements for improved properties. In response to these new requirements, several new glass finishes, new glasses with higher moduli, and many new resin systems have been developed. Some of these developments have yielded an improved product; others have shown promise of superior performance, only to fail when tested in a severe environment such as long-time immersion in water. The problem to date has in part arisen from a lack of understanding of the mechanism of reinforcement in glass-resin systems. The components of reinforced plastics are currently evaluated by the empirical method of fabricating and testing reinforced panels. Information regarding the interaction of the resin with the glass or glass-finish is required in order to understand the reinforcement mechanism and to make a rational selection of the proper components.

One means of determining this interaction is through investigation of the adsorption of polymers. A large amount of information regarding the adsorption of small molecules, both from the gaseous phase and from solution, has been published. Only relatively recently has there been any serious attempt to study the adsorption of polymer molecules at solid surfaces. This interest has developed because of the applicability of the information in several industrial areas.

Research workers concerned with the reinforcing properties of carbon black in rubber are studying adsorption; these reinforcing properties have been ascribed to the selective adsorption of the elastomer on the carbon black (1).[1] The adhesion of paint films to various surfaces is also obviously intimately involved with adsorption. Use of adsorption chromatography to fractionate polymers is now the subject of several investigations.

This report is concerned with the adsorption of polymers from relatively dilute solution onto solids. It includes a review of work in our own laboratory, which is primarily concerned with the adsorption of polyesters onto glass and silica, and the work of others as reported in recently published articles on the same subject.

Factors in adsorption

Although the adsorption of a small molecule can be rather involved, it can be considered as a known structure. On the other hand, for polymers the nature and the adsorbability of the end groups and the monomeric unit recurring along the chain, together with inter- and intramolecular interac-

*Reg. U. S. Pat. Off.

†National Bureau of Standards, Washington 25, D. C.

A portion of the research reported in this article was performed as part of a project sponsored by the Bureau of Naval Weapons. The article was presented at the IUPAC Symposium of the 12th International Congress on Plastics in Torino, Italy, Sept. 28, 1960.

[1]Numbers in parentheses designate references at end of article, p. 195.

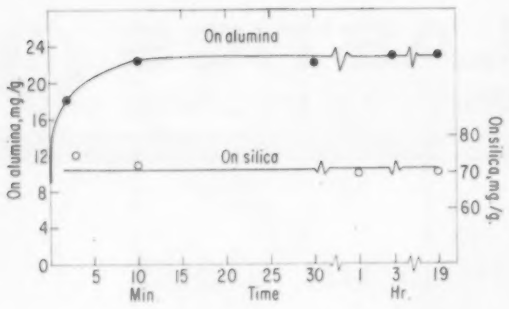


FIG. 1: Adsorption of poly(neopentyl succinate) from chloroform solution onto alumina and silica as a function of time at 30° C.

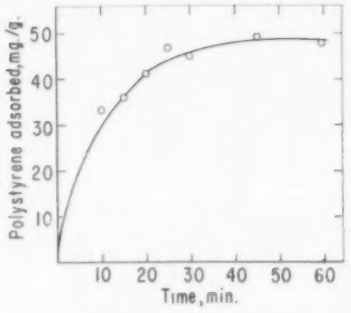


FIG. 2: Adsorption of polystyrene from a 1% w/v solution of unfractionated polymer in 1% v/v methanol and 99% v/v methyl ethyl ketone onto charcoal as a function of time at 25° C. (Reference 6).

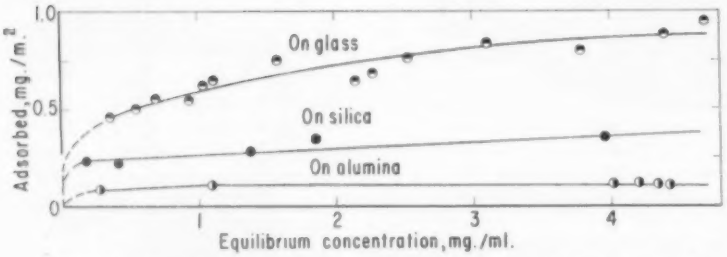


FIG. 3: Adsorption of poly(neopentyl succinate) from chloroform solution onto glass, silica, and alumina at 30° C. (Reference 1a).

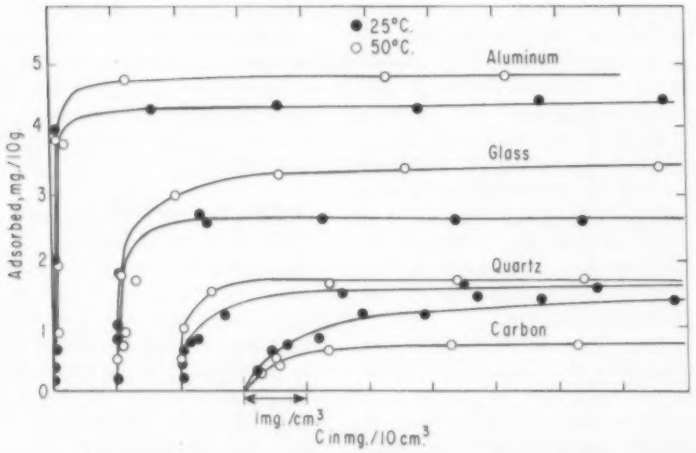


FIG. 4: Adsorption of poly(methyl methacrylate) from toluene solution onto several adsorbents. From Jenckel and Rumbach (Reference 9).

tions, present a much more complex problem.

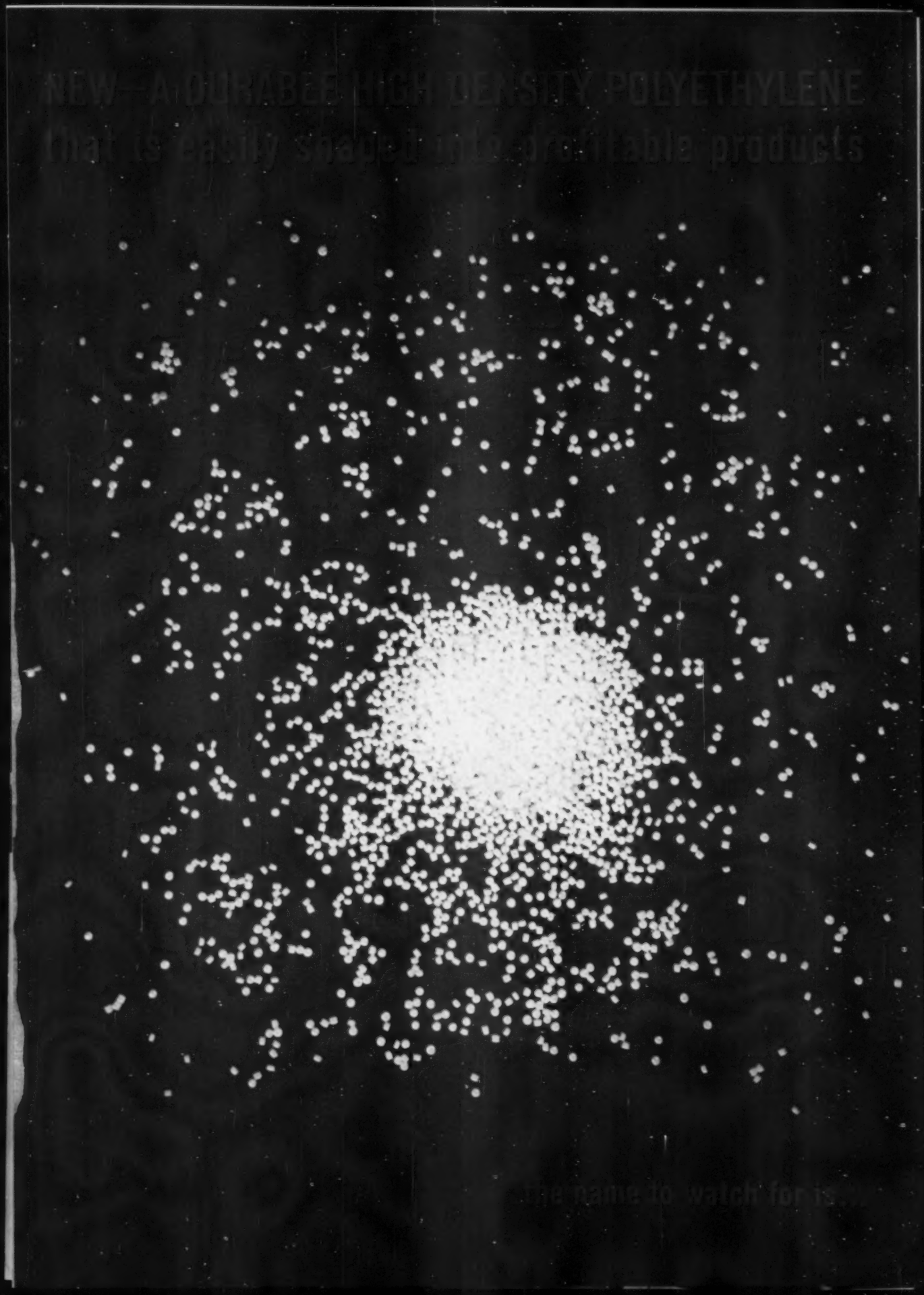
The following factors must be considered in any exploration of the adsorption behavior of polymers: 1) rate of adsorption, 2) nature of adsorbent surface, 3) effect of solvent, 4) molecular weight of polymers, 5) temperature, 6) adsorption-desorption reversibility, and 7) configuration of the molecule.

The rate of adsorption of large molecules is partially determined by the nature of the adsorbent surface. A polymer molecule will diffuse slowly into the interior of a porous material such as charcoal; it will relatively quickly adsorb on the surface of a nonporous material such as glass. The chemical reactivity of the surface, as well as the presence of any other preadsorbed material such as water or oxygen, is also of concern.

The adsorption of solvent by the adsorbent as well as the polymer-solvent interaction must be considered when studying the adsorption of a polymer from dilute solution. There is competition by the adsorbent and the solvent for the polymer as well as competition by the solvent and polymer for the adsorbent. Differences are expected, therefore, between good and poor solvents and between solvents with the same solvating power but different affinities for the adsorbent.

The effect of molecular weight on adsorption provides some indication of the configuration of the polymer on the surface of the adsorbent. If there is no change in the weight of material adsorbed with increasing molecular weight, then it is assumed that the molecules are lying flat on the surface. However, an increase in molecular weight usually results in an increase in the weight adsorbed on a nonporous solid, indicating that most polymer molecules do not lie flat on the surface to form a monolayer. It is also of interest to determine whether preferred adsorption of high or low molecular weight material, that is, fractionation, occurs during the adsorption process.

Both positive and negative temperature coefficients of adsorption have been reported for polymer molecules. The coefficient for a polymer may change sign with solvent. The **(To page 129)**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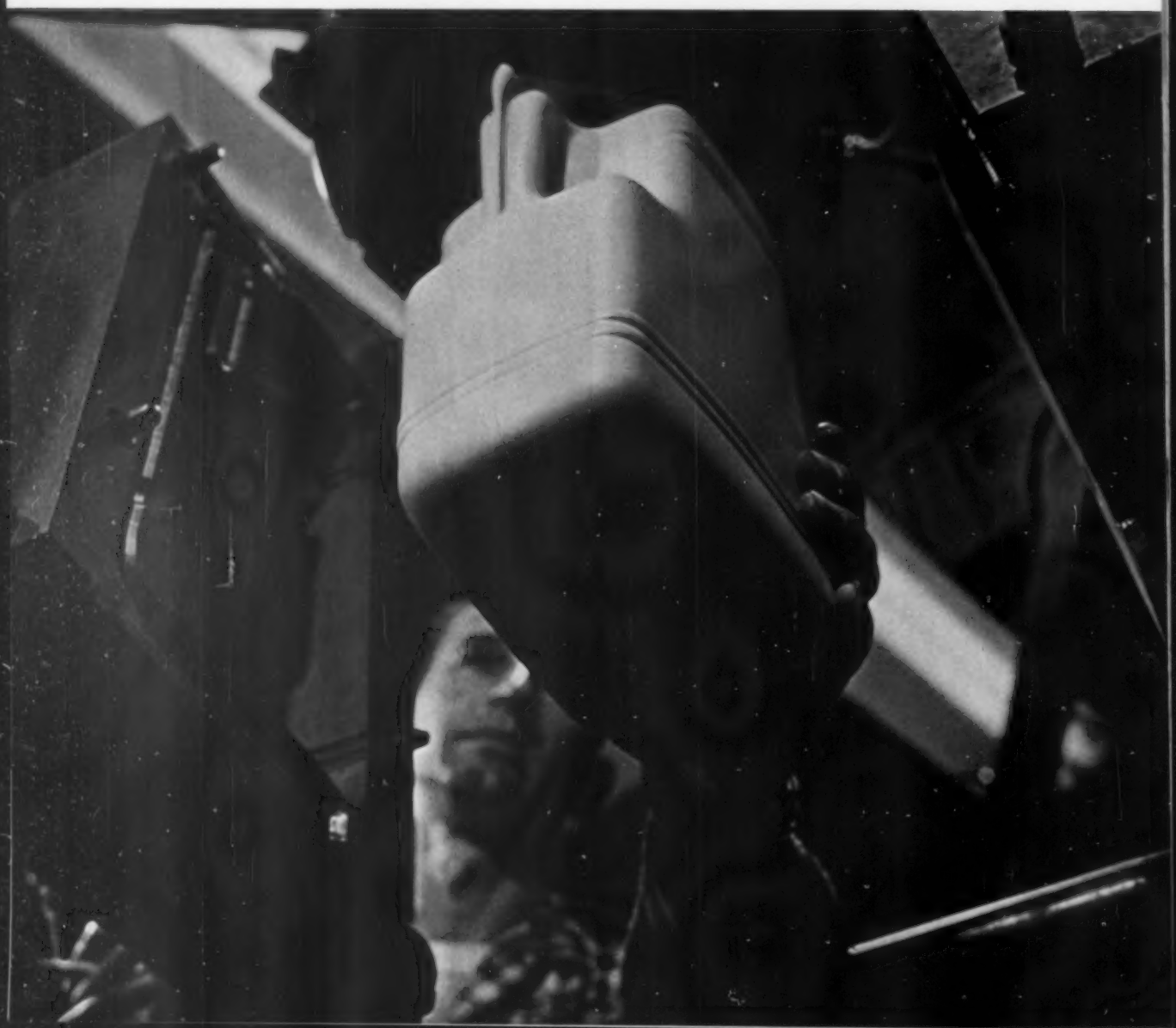

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Density	g/cc	D648-56	0.95	0.95	0.95
Molecular Weight	———		50,000	80,000	100,000
Melt Index (condition E)	g/10 min	D1238-57T	0.1-0.2	0.04-0.08	0.001
Flow Index (a) (condition F)	g/10 min	D1238-57T	24.0-28.0	8.5-9.3	4.0-5.6
Intrinsic Viscosity	———	D1601-58T	2.3-3.0	3.1-3.7	3.8-4.8
Vicat Softening Temperature	°C	D1525-58T	119	121	122
Ultimate Tensile Strength, 20 ipm	psi	D412-51T	2250	2450	2700
Tensile at Yield, 20 ipm	psi	D412-51T	3450	3450	3450
Elongation, 20 ipm	%	D412-51T	120	320	560
Impact Strength (b)					
⅛ x ½ bar	ft/lbs				
	in notch	D256-54T	19	31	36
¼ x ½ bar	"	D256-54T	8	17	24
½ x ½ bar	"	D256-54T	0.9	1.9	4.3
Stiffness in Flexure	psi	D747-50	115,000	115,000	120,000
Hardness	Shore D	D1706-59T	50	60	60
Environmental Property					
Environmental Stress Cracking (c)					
With Anti-oxidant	hrs.		65	445	>800
Without Anti-oxidant	hrs.	D1693-59T	40	230	500
Thermal Embrittlement (d)					
With Anti-oxidant	hrs.	(d)	185	>1000	>1000
Without Anti-oxidant	hrs.	(d)	70	95	700

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driving force for adsorption is dependent on the change in free energy, ΔF. From the relation $\Delta F = \Delta H - T\Delta S$, where ΔH is the heat of reaction, T is the absolute temperature, and ΔS is the entropy change, and the fact that ΔH may be positive or negative, it is obvious that the magnitude of ΔS must be very important. In general, the effect of temperature is relatively small; that is, there are only small changes in the adsorption isotherms with changes in temperature. Therefore, ΔS must be relatively large to obtain an appreciable driving force ($\Delta F < 0$).

Most theoretical treatments of adsorption assume a thermodynamically reversible system. The Langmuir and the Simha-Frisch-Eirich (SFE) equations have been applied to polymer systems. The SFE isotherm was developed from a statistical treatment of polymer adsorption. However, some polymer systems, particularly those adsorbed on glass, may be irreversible and not subject to such treatment.

The conformation of the polymer molecule on the solid surface and the nature and strength of the bonds formed are, of course, of extreme importance to the subject of adhesion. Evidence is somewhat conflicting regarding the conformation. There is evidence to indicate that the large polymer molecules are attached to the surface in a looped or coiled configuration. However, it appears that smaller molecules such as polyesters may be attached in a flatter fashion. As more polymer is deposited, it also appears that the shape of the large molecules may be laterally compressed with longer loops extending into the solution. The attachments can be relatively strong, as in the case of glass; however, they are apparently secondary bonds, because the polymer can be removed with stronger solvent.

Experimental procedures

A weighed quantity of adsorbent powder was mixed with a measured volume of polymer solution of known concentration. Tubes containing the solution and adsorbent were sealed and shaken or rotated at a constant temperature for a given period of time.

Subsequent to the adsorption, some of the solution was separated

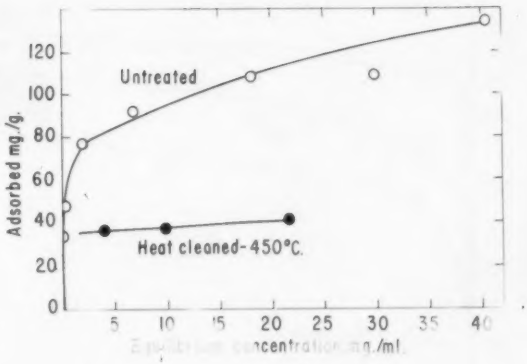

FIG. 5: Adsorption of poly(ethylene *o*-phthalate) from chloroform solution onto untreated and heat cleaned silica at 30° C.

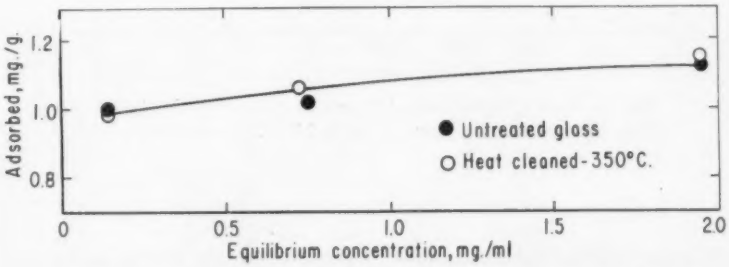

FIG. 6: Adsorption of poly(ethylene adipate) from toluene solution onto untreated and heat cleaned Type E glass at 30° C. (Reference 1a).

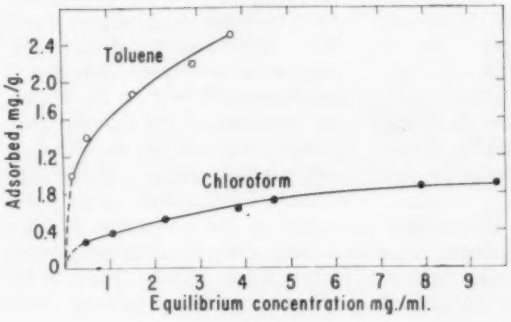

FIG. 7: Adsorption of poly(trimethylene adipate) from toluene and chloroform solutions onto Type E glass at 30° C. (Reference 1a).

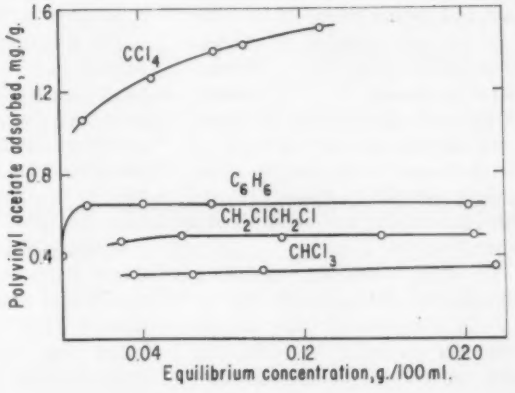

FIG. 8: Effect of solvent on adsorption of poly(vinyl acetate) onto iron at 30.4° C. From Koral, Ullman, and Eirich (Ref. 2).

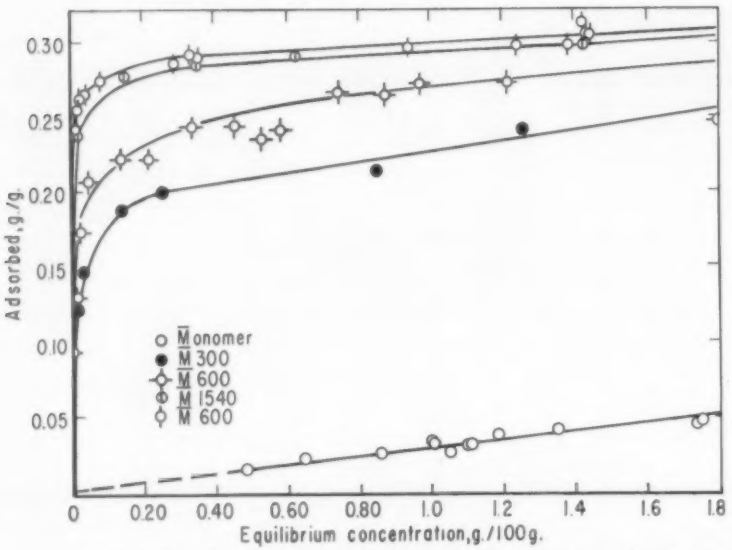

FIG. 9: Effect of molecular weight on adsorption of poly(ethylene glycol) from aqueous solution onto carbon at 25° C. From Reference 16.

from the adsorbed polymer-adsorbent solid. For polyesters the mixture was centrifuged and the solution separated by decanting or pipetting. The quantity of polymer adsorbed was determined from the change in concentration of the polymer solution as measured by the change in the carbonyl absorption band at 5.8 microns in the infra-red (1a). Koral, Ullman, and Eirich (2), Perkel (3), and others have also used characteristic bands in the infra-red in order to determine concentration changes.

Several other ways of measuring the concentration of polymers have been used in adsorption studies. These include: direct weighing of the polymer after evaporation of the solvent (4, 5); precipitation, drying, and weighing of polymer (5, 6, 7, 8); addition of a precipitant and measurement of turbidity (1a, 9); measurement of changes in refractive index with a differential refractometer (5). The amount of polymer adsorbed can be measured directly on certain types of flat surfaces by the use of radioactively labeled polymer (10). In this instance, the polymer is usually labeled with C^{14}.

To study desorption, a known quantity of the solution was removed, a known quantity of solvent was placed in the tube, the tube was rotated at constant temperature, usually over a period of several days, and the solution was reanalyzed.

Rate of adsorption

In any adsorption study, it is necessary to know when equilibrium has been attained. It is, therefore, usual practice to determine the rate of adsorption. This rate is dependent not only on the chemical structure of the polymer and solvent, but also on the chemical and physical nature of the adsorbent. Adsorption was fairly rapid on the nonporous systems studied, often reaching equilibrium within a few minutes. The rate for porous adsorbents, such as charcoal, is dependent on the rate of diffusion of the large molecules into the pores. Several hours or even days can elapse before equilibrium is attained in such systems.

The results of rate studies for the adsorption of a relatively low molecular weight polyester, poly(neopentyl succinate), onto a porous adsorbent, alumina, and a nonporous adsorbent, silica, are shown in Fig. 1, p. 124. The rate on alumina was slower, although equilibrium was attained within 15 minutes. In the case of glass, equilibrium occurred within 15 seconds. Hobden and Jellinek (6) found that longer time periods were required for adsorption of polystyrene on a porous adsorbent, charcoal, as shown in Fig. 2, p. 124. In addition, they reported that the rate increased with a poor solvent (low solvation). To insure that apparent adsorption equilibrium had occurred, Frisch, Hellman, and Lundberg (11) allowed a minimum of 10 days.

It appears, therefore, that the adsorption of polymers from dilute solution is rather rapid, the polymer displacing solvent from the surface. Diffusion of the polymer through the solvent is rapid compared with diffusion through pores.

Nature of adsorbent surface

In addition to physical considerations, such as porosity, the chemical nature of the adsorbent is important. Fig. 3, p. 124, shows the adsorption of poly(neopentyl succinate) from chloroform solution onto three surfaces—glass, silica, and alumina. The Type E glass, a low-soda lime-alumina-borosilicate glass used for the production of glass fibers for laminates, and the silica, a rubber-reinforcing agent, are nonporous materials. The Type E glass was ground from marbles and had a surface area of about 0.68 $m.^2/g$. The silica was prepared by the vapor-phase hydrolysis of a silicon compound; it had a particle size of 15 to 20 millimicrons and a surface area of about 200 $m.^2/g.$, as reported by the manufacturer. The alumina also had a surface area of about 200 $m.^2/g.$; since it is a porous material, it is possible that some of its surface area was unavailable to the polymer molecule.

In addition to silica, Type E glass contains calcium, aluminum, boron, and magnesium oxides. Inasmuch as considerably larger quantities of polymer were adsorbed on the glass relative to the other adsorbents, it is possible that the positively charged metallic ions, in addition to the silicon, present in the surface of the glass may have some advantages for bond formation, perhaps with the oxygen of the ester group.

Jenckel and Rumbach (9) studied the adsorption of several polymers on glass, quartz, aluminum, and carbon. Their aluminum was apparently alumina on the surface. The adsorption of poly(methyl methacrylate) onto these adsorbents from toluene is shown

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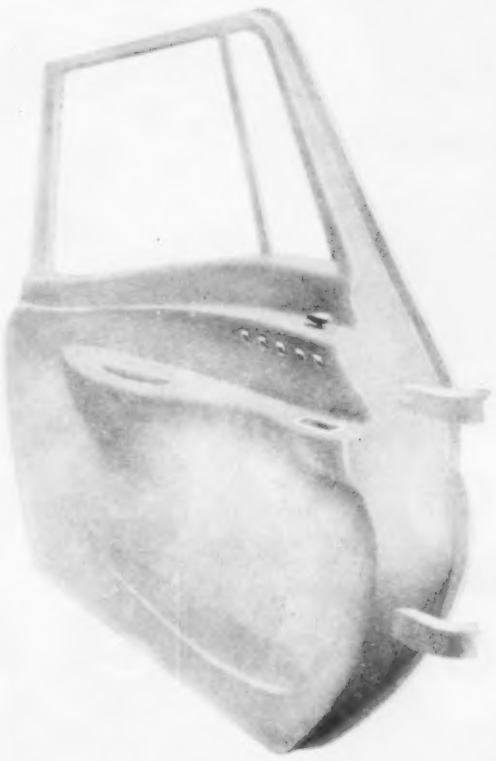

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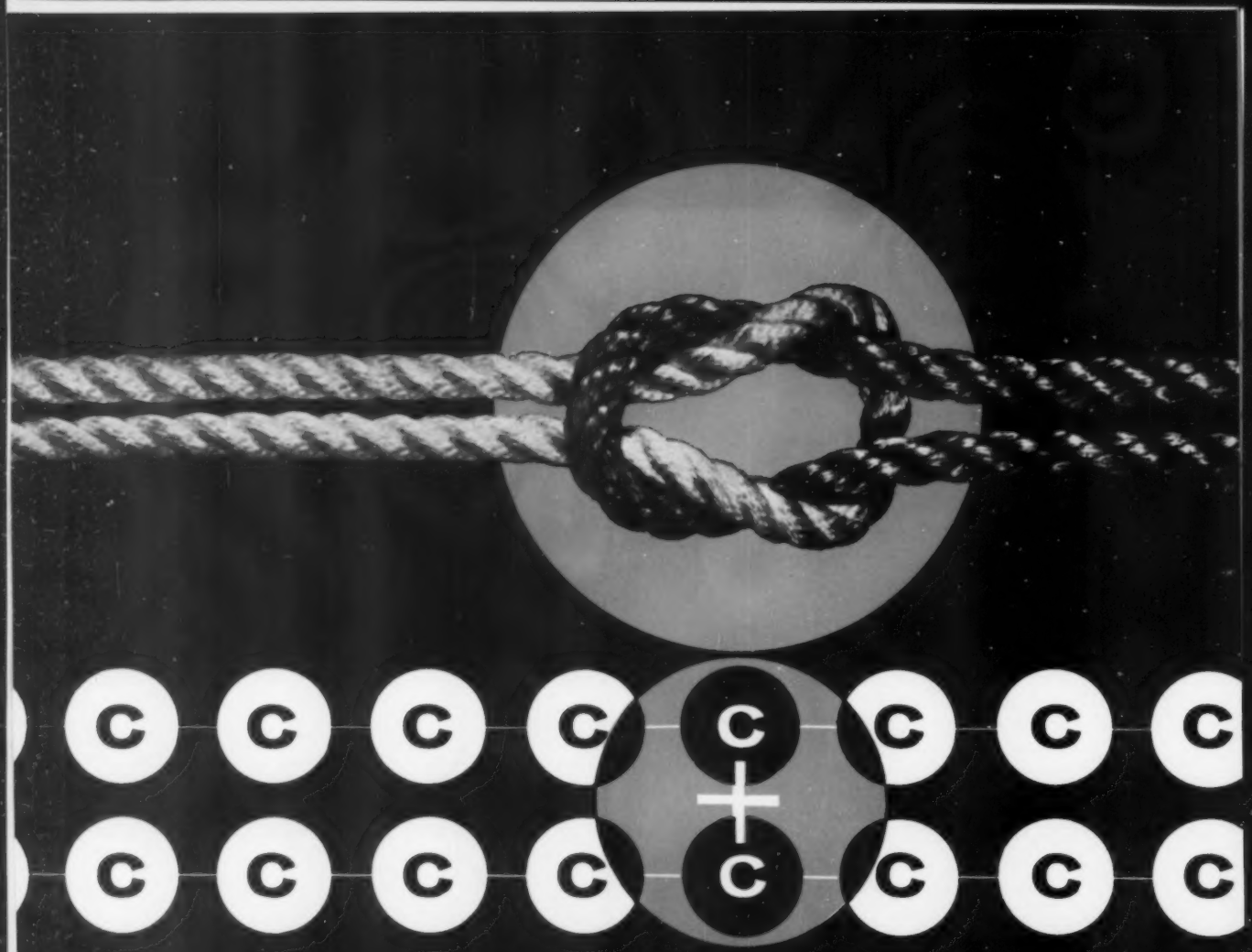

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in Fig. 4, p. 124. If the quantity adsorbed per square meter of adsorbent surface is plotted instead of the quantity per mg. of adsorbent, the spread among the curves will change but the ranking will be the same. More poly(methyl methacrylate) was adsorbed on the aluminum (alumina) than on the other adsorbents, contrary to our results. This can be explained by the pore size factor previously discussed. The glass adsorbed more polymer than the quartz.

It is also possible to alter the nature of the surface of an adsorbent by changing its "water" content. The effect of the adsorption of poly(ethylene-*o*-phthalate) onto unheated and heated silica is shown in Fig. 5, p. 129. The tubes containing the silica were sealed onto a vacuum system and heated at 450° C. for 48 hours. The solvent was vacuum-distilled over calcium hydride into adjoining tubes containing polymer. The assemblies were sealed from the vacuum system and the solution added to the adsorbent by breaking open a "break-off" seal. The remainder of the adsorption procedure was the same as has been previously described. At the same time an adsorption run was made in the conventional manner on silica that was at equilibrium with the atmosphere.

The decrease in the amount adsorbed is undoubtedly due to alterations in the surface of the silica. In addition to removal of water, Si-OH bonds have probably been changed to Si-O-Si bonds, reducing the number of adsorption sites. McDonald (12) in a study of the surface functionality of amorphous silica reported that when silica is degassed below 300° C., the number of surface silanol groups remains unchanged. Above 300° C. he found that certain silanol groups react, splitting out water and forming siloxane bonds on the surface and even between adjoining silica particles. This appears to be consistent with the decreased adsorption results and with difficulties in obtaining reproducible results from one run to another. A plateau has not been reached in the upper curve of Fig. 5, even at concentrations as high as 40 mg./ml., indicating that saturation has not been attained.

Frish, Hellman, and Lundberg (11) reported a decrease in the adsorption of polystyrene on a carbon black when the carbon was vigorously dried by heating and outgassing. Saturation of the system with water also lowered the total adsorption relative to carbon samples conditioned at 50% relative humidity.

Type E glass was heated in a vacuum system for about 24 hr. at 350° C. Subsequently the polymer solution was added by breaking open the tube while it was immersed in the polymer solution. Traces of water were undoubtedly still present on the glass surface. Figure 6, p. 129, shows that in quantities above these trace amounts, water does not play a significant role in the adsorption of polyesters on glass.

Effect of solvent

When an adsorbent is mixed with a relatively dilute polymer solution, it is reasonable to expect that if the solvent is adsorbable, the surface will initially be covered with solvent molecules. To be adsorbed, polymer must then replace solvent molecules. The amount of polymer adsorbed, therefore, depends on the differences in the energy of adsorption between the adsorbent and the solvent, and the adsorbent and the polymer.

In addition to the adsorbent-polymer and adsorbent-solvent interactions, one must also consider polymer-solvent interactions. A polymer molecule would be more solvated in a good solvent and, therefore, would have a larger radius of gyration and occupy more space than in a poor solvent. In the poor solvent it would be more tightly coiled. The amount of polymer that can fit per unit area of adsorbent surface is dependent on the size of the coil. Of course, the interaction between coils as well as the possible compression or alteration of the shape of these coils as more polymer is adsorbed must also be considered.

The effect of good and poor solvent on adsorption **(To page 192)**

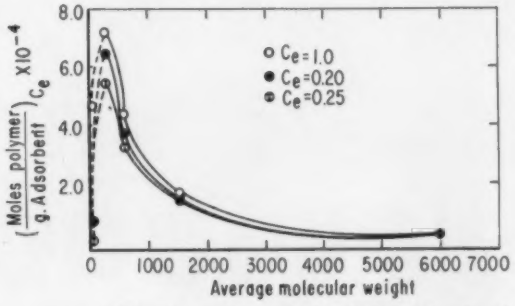

FIG. 10: Moles of poly(ethylene glycol) adsorbed at several equilibrium concentrations at 25° C. as a function of molecular weight.

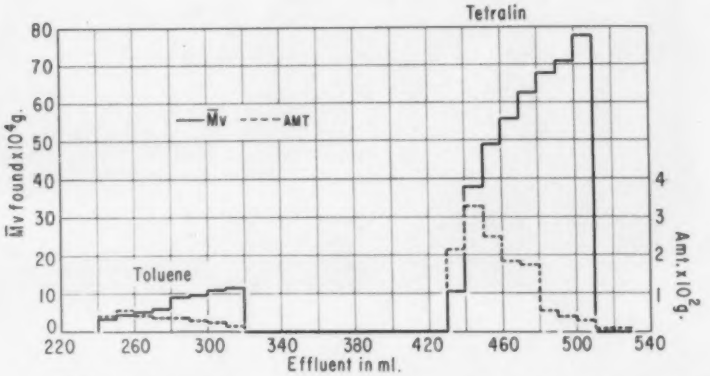

FIG. 11: Chromatogram of polystyrene on carbon-Celite (diatomaceous earth), using successively 2-butanone, toluene, and Tetralin (1,2,3,4,- tetrahydronaphthalene) as eluents at 25° C. From Yeh and Frisch.

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Epoxidized polyolefin resins

Representative cure systems for a spectrum of mechanical and electrical properties

By C. W. Johnston* and F. P. Greenspan*

Oxiron resins represent a versatile family of new epoxy materials capable of curing through reactive double bonds as well as through epoxy groups. This combination enables one to produce highly crosslinked thermoset resins with excellent high-temperature mechanical and electrical properties, and, particularly, outstanding resistance to creep. The minimal plastic flow of peroxide-cured epoxidized polyolefin resins results in excellent dimensional stability under load, especially advantageous for structural application. Application of these resins in some special types of reinforced plastics is described.

Oxiron[1] resins represent a family of epoxidized polyolefins (1,2),[2] structurally distinguished from the conventional epoxy resins of commerce based upon epichlorohydrin-bisphenol condensates. They have broad applicability to casting, laminate, adhesive, and protective coating use. The chemistry of these materials, with particular emphasis on their reactivity and curing behavior, properties, and application in some types of reinforced plastics are discussed in this article.

Within the large family of these resins are a number of generic series, related to each other by structure. One such series (the only one currently available) is the Oxiron 2000 series, characterized by an aliphatic backbone structure. Figure 1, right, is a simplified version of an Oxiron structure, illustrating the types of functional groups present. This diagram is not meant to illustrate any quantitative relationship between functional groups. These highly functional resins contain reactive double bonds and hydroxyl groups, in addition to epoxy groups. Some 12 or more reaction sites are distributed along the hydrocarbon backbone chain. It will be noted that multiple epoxy groups are present in the structure and that these are positioned both internally and externally along the polymer chain. This contrasts with conventional epichlorohydrin epoxy resins which contain two, and only two epoxy groups, both in terminal positions. The reactive double bonds enable one to cure the epoxidized polyolefins by peroxide catalysis as well as through conventional epoxy curing agents; accordingly, they may be thought of as combining, in only one structure, the reactivity of a polyester resin with that of an epoxy resin.

The physical properties of three members of the 2000 series are given in Table I, p. 136. The 2001 resin is a low viscosity version of the 2000 resin. The 2002 resin is a relatively low viscosity resin containing reactive monomer, notably styrene.

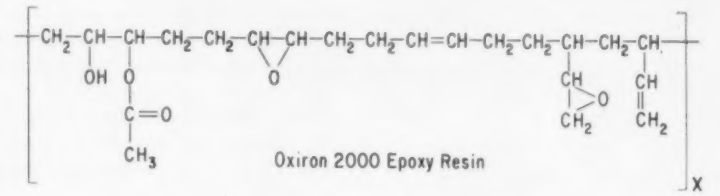
With such striking differences in molecular structure, it is not surprising that the epoxidized polyolefin resins show major reactivity and property differences from conventional epoxies. A number of highlighting and distinguishing features are listed in Table II, p. 136.

Density and reactivity

The 2000 resin has a specific gravity of 1.01. This is approximately 20% lower than an epichlorohydrin-bisphenol epoxy. Depending upon curing agent used, cured epoxidized polyolefins are 10 to 20% lower in density than the conventional resins. This has major structural implications, as well as providing an economic advantage.

The high functionality of these resins provides numerous sites for crosslinking with consequent benefit to chemical and mechanical properties. Depending upon the curing agents employed, cured resins can be obtained ranging from rubbery solids through rigid materials (3,4).

Epoxy resins in their uncured state are essentially linear in structure, in the form of liquids or thermoplastic solids. To cure these materials one must crosslink adjacent chains, thereby building up the molecular weight of the structure and rendering it insoluble and infusible (thermoset). In a conventional epoxy resin this is achieved through reactions of the epoxy and/or hydroxyl groups present in the structure. Crosslinking can



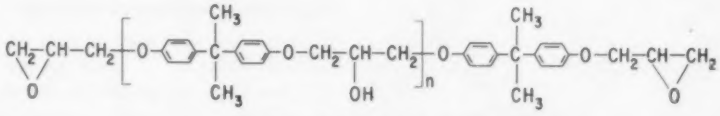


FIG. 1: Structural formulas.

*Food Machinery & Chemical Corp.
Based on a paper presented at the S.P.I. Reinforced Plastics Conference, Chicago, Ill., Feb. 1961.
[1]Trademark of Food Machinery & Chemical Corp.
[2]Numbers in parentheses designate references at end of article, p. 198.

Table I: Typical properties of uncured epoxy resins

Property	Oxiron resin 2000	2001	2002
Viscosity, poise at 25° C.	1800	160	15
Active ingredients, %	100	100	100
Specific gravity	1.010	1.014	0.985
Epoxy, %	9.0	11.0	6.9
Epoxy equivalent[a]	177	145	232

[a]Number of grams of resin containing 1 g. mole of epoxide.

Table II: Some characteristic properties of Oxiron epoxy resins

1. Low density.

2. Multifunctional reactivity.
Can be peroxide cured through reactive double bonds as well as crosslinked through epoxy groups. Can be formulated to give products ranging from rubbery solids to rigid highly thermoset resins.

3. High-temperature properties.
Unique flat heat distortion curves; less creep at elevated temperatures.

4. Electrical properties.
Good electrical characteristics with outstanding constancy over a wide temperature range for peroxide-cured resins.

5. Adhesion.
Outstanding adhesion to a variety of substrate materials.

be accomplished by reaction with polyfunctional active-hydrogen compounds, *e.g.*, polyamines and anhydrides, or by a condensation-polymerization reaction in the presence of a Lewis acid catalyst (ionic), such as boron trifluoride. The epoxidized polyolefin resins present an additional curing degree of freedom through possession of reactive double bonds. Curing can be effected thereby with peroxide and ionic catalysts, used singly or in combination with conventional polyfunctional curing agents. Further, various reactive monomers such as styrene can be grafted on to the polymer chain through peroxide catalysis at the site of the double bond. The presence of this double bond makes it possible to co-react these resins with polymers containing double bonds, such as polyesters. By such a technique a whole host of promising and interesting plastic alloys can be achieved.

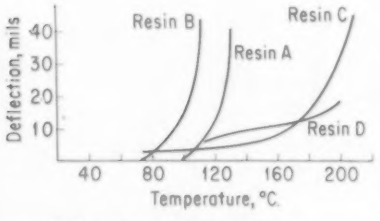


FIG. 2: Heat distortion curves of epoxy resins.

The far-ranging reactivity of the epoxidized polyolefin resins, shown in Table III, p. 138, allows considerable freedom of choice in the selection of a curing system custom tailored to a specific combination of end properties. Table IV, p. 140, illustrates flexible cures with a dimeric acid. Table V, p. 140, illustrates a low-viscosity curing system that contains monomer. Table VI, p. 140, illustrates Oxiron resin curing systems that provide materials with excellent high-temperature properties.

High-temperature properties

These characteristics cannot be defined simply by a single parameter but must be studied in terms of specific engineering requirements. Such high-temperature aspects as distortion under load, loss in strength or modulus, electrical performance, and thermal flow or creep, may be of importance singly or in combination.

Heat distortion. One commonly accepted measure of the high-temperature behavior of a resin is the heat distortion temperature. This test measures the temperature at which a simple beam deflects a specified amount (10 mils) when placed under a standard stress. Recently, this test has been questioned because the system is far from being in thermal equilibrium (5). Others have suggested that the arbitrary specification of a deflection does not truly evaluate a resin. Therefore, it is becoming customary to present a curve showing deflection versus temperature; in this manner it is possible to distinguish between materials that catastrophically break down and those that slowly yield.

Figure 2, below, shows the curve of a conventional epichlorohydrin-bisphenol epoxy material (Resin A) as well as those of several Oxiron systems (Resins B, C, and D) described in Table VI. Resins A and B are examples of materials that show rapid distortion as soon as a critical temperature is reached. Resin B is based upon a saturated anhydride-glycol cure recipe. Variations in the ratio of ingredients and cure cycle can change the 10-mil intercept of the curve, but do not drastically alter its shape. The curve for Resin C illustrates the changes produced by slightly adjusting the glycol ratio and adding a peroxide to take advantage of the crosslinking possible because of the unsaturation present. The deflection curve has been markedly flattened and the steep upward bend changed to a somewhat more gentle curve. These properties can be further improved by increasing the amount of peroxide. This type of material does not begin distorting until considerably higher temperatures are encountered and even then its response is more gradual. Resin A would yield and creep extensively if subjected to stress at or close to the heat distortion temperature. In contrast, under the same conditions, Resin C would show only a slight tendency to deform.

For ultimate high-temperature properties a material exemplified by Resin D, based on an unsaturated

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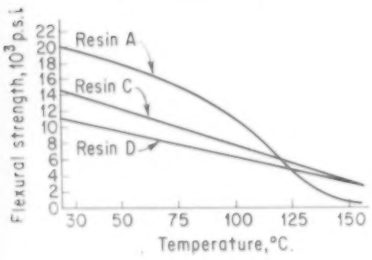
anhydride-glycol and a peroxide, would be most desirable. This type of formulation can lead to heat distortion temperatures well over 200° C.; the important characteristic is the flatness of the curve. To develop the remainder of this curve, special equipment is required because the solder used to fabricate the usual heat distortion bath begins to melt somewhat above 220° C. Resin D has a flat curve but only a moderate heat distortion temperature. Such a material, in spite of its lower heat distortion temperature, can be expected to show only a small deflection under load at temperatures in the range of 200° C. In most cases the deformation is recoverable when the temperature is again lowered. This is because the deflection was due to a reduction in flexural modulus at higher temperature and was not due to actual flow of the material. This aspect will be discussed further in the following section on "Stress relaxation."

FIG. 3: Flexural strength vs. temperature of epoxy resins.



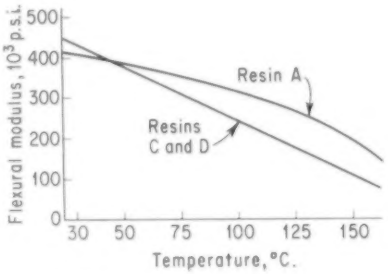


FIG. 4: Flexural modulus vs. temperature of epoxy resins.

Flexural properties versus temperature. Although the heat distortion temperature gives a vague suggestion of high-temperature properties, it is not very useful in elucidating the engineering properties of a given material. Flexural strength and flexural modulus therefore have been determined as a function of temperature. These values were determined by placing the samples in a furnace and maintaining them at the test temperature for 30 min. to achieve thermal equilibrium, followed by testing at that temperature. The results are plotted in Figs. 3 and 4, above.

Although Resin A started out with the highest flexural strength, it dropped to a very low value at 150° C. An epichlorohydrin-bisphenol resin formulated for high-temperature resistance, *e.g.*, using Nadic[3] methyl anhydride and benzyl dimethylamine, would have exhibited flexural strengths at 150° C. comparable to Resins C and D.

All the resins exhibited show loss of stiffness or modulus at elevated temperatures. This loss could be associated with deflections observed in the heat distortion test. Calculations, however, show that the deflections for materials characterized by sharp breaking heat distortion curves (Resins A and B) are far greater than predicted from loss of modulus alone. This suggests other factors are operating, notably stress relaxation or creep.

Stress relaxation. Cast samples of resin were raised to the test temperature, loaded as a simple beam, and strained a predetermined amount by driving the cross head a given distance. The cross head was stopped and the stress indicated by the load cell was recorded as a function of time. Tests of this

Table III: Reactivity of Oxiron epoxy resins

Curing agent	*Features*
	1. Epoxy functional group
Polyamines	Long pot life at low temperatures; rapid cure at elevated temperatures. Catalyzed by phenols. Sluggish with secondary amines.
Anhydrides Anhydrides-glycols Polybasic acids	Properties can be varied from flexible to hard rigid. Enhanced reactivity over conventional resins. Good low-temperature curing. Use of glycols or aliphatic side chain anhydrides imparts flexibility. Can be used in conjunction with peroxide curing. Can be further acid catalyzed.
Polyphenols Phenolic resins	High-temperature cure. Hard rigid materials.
Polymercaptans	Flexible products.
Ionic (*e.g.*, BF_3)	Rapid reaction. Frequently used in conjunction with other cure systems.
	2. Double-bond functional group
Organic peroxides (free radical initiators)	Most frequently used with anhydride or anhydride-glycol cure. Gives highly thermoset resin. Excellent high-temperature and electrical properties.
Monomers (*e.g.*, styrene)	Low-cost, low-viscosity systems; ideal for laminates. Monomer copolymerizes with Oxiron through peroxide catalyst. Most frequently used with anhydride cure. Use of unsaturated anhydride provides additional site for copolymerization.
Ionic	Rapid at low temperatures. Also used in conjunction with other cure systems.
	3. Hydroxyl functional group
Anhydrides	Resin has low hydroxyl content. Represents additional site of cross-linking.
Organic acids	Significant reaction in preparation of resin ester coatings.
Epoxides	Secondary reaction occurring during normal curing.

[3]Trademark of National Aniline Division, Allied Chemical Corp. Nadic anhydride is bicyclo (2, 2, 1) 5-heptene 2, 3-dicarboxylic anhydride.

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Table IV: Flexible cure systems for epoxidized olefin resin

Formulation		
Oxiron 2000	100	100
Dimer acid (Empol[a] 1014)	100	100
Varox[b] liquid (peroxide)	—	1
Cure cycle		
2 hr. at 80° C.		
24 hr. at 155° C.		
Properties		
Tensile strength, p.s.i.	690	890
Elongation, %	80.6	59.2
Shore A hardness	65.5	73.5

[a]Trademark of Emery Industries Inc.
[b]Trademark of R. T. Vanderbilt Co. Inc.

Table V: Low-viscosity cure system for epoxidized olefin resin

Formulation	
Oxiron 2000	100
Styrene	30
Maleic anhydride	31
Propylene glycol	8
Dicumyl peroxide	0.5
Cure cycle	
3 hr. at 90° C.	
3 hr. at 130° C.	
Properties	
Flexural strength, p.s.i.	16,000
Flexural modulus, p.s.i.	490,000
Tensile strength, p.s.i.	7,400
Tensile modulus, p.s.i.	410,000
Elongation, %	2.4
Heat distortion temperature, °C.	98
Rockwell hardness	M83

Table VI: Cure systems for epoxy resins used in high-temperature studies[a]

	Resin A[b]	*Resin B*	*Resin C*	*Resin D*
Type of resin	Epichlorohydrin-bisphenol resin	Oxiron 2000	Oxiron 2000	Oxiron 2000
Formulation				
Resin	100	100	100	100
Hexahydrophthalic anhydride	85	80	80	—
Maleic anhydride	—	—	—	31
Propylene glycol	—	8	3	8
Benzyl dimethylamine	1	—	—	—
Varox[c] liquid	—	—	3	—
Dicumyl peroxide	—	—	—	0.5
Cure cycle				
Hours at 80° C.	3	—	—	2
Hours at 120° C.	—	2	2	4
Hours at 155°C.[a]	4	4	4	—
Properties				
Flexural strength, p.s.i.	20,600	17,300	19,600	12,100
Flexural modulus × 10^{-5}, p.s.i.	476	440	501	440
Tensile strength, p.s.i.	—	10,100	—	6,600
Tensile modulus × 10^{-5}, p.s.i.	—	433	—	365
Tensile elongation, %	—	3.68	—	2.14
Copper-clad laminate[d] peel strength (avg.), lb.	—	9.3 to 10.5	9.7 to 11.0	—

[a]All heat distortion temperatures and high-temperature strength and electrical properties shown in Figs. 2 through 6 were obtained on samples postcured for 24 hr. at 155° C. [b]Epoxy equivalent of this resin was approximately 180. [c]Trademark of R. T. Vanderbilt Co. Inc. [d]AAC 2570, made by Rubber & Asbestos Corp. See Footnote [a] of Table VIII for construction of the laminate.

nature were generally permitted to run overnight.

Figure 5, p. 143, shows stress relaxation curves for Resins A and D (Table VI). Resin A, which had a low heat distortion temperature and a steep heat distortion versus temperature curve, relaxed to zero stress in a matter of 50 min. at 155° C. Resin D relaxed to about 50% of the stress and remained constant thereafter. Even after 16 hr. the residual stress was still about 50 percent. Such a material would maintain its physical structure at high temperature under moderate stress, whereas Resin A would flow in conformance to the applied stress if sufficient time elapsed.

Electrical properties. Quite apart from the mechanical properties at higher temperatures is the behavior under electrical stresses. In this category we have measured dielectric constants (K) and dissipation factors (D) as a function of temperature. Both of these values are of use in characterizing a dielectric and may be considered separately. However, in order to simplify the graphic presentation we have plotted a loss factor which is the product of the dielectric constant and the dissipation factor (KD). This is related to the energy lost in the dielectric material. It largely reflects changes in D since the value of K does not vary widely.

Figure 6, p. 143, shows the

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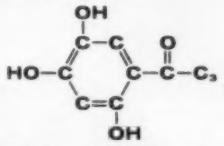

Trihydroxybutyrophenone

Form	*pale yellow solid*
Melting point	*150-153°C.*
Solubility	*alcohol, oils*

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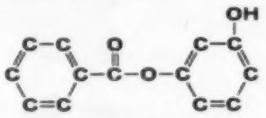

Resorcinol Monobenzoate

Form	*white crystalline solid*
Melting point	*132-135°C.*
Solubility	*most organic solvents*

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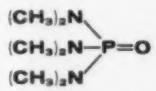

Hexamethylphosphoric Triamide

Form	*colorless liquid*
Boiling range, 739.4 mm.	*230-232°C.*
Solubility	*polar and non-polar solvents*

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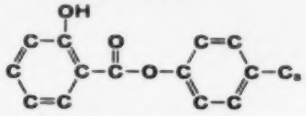

p-Octylphenyl Salicylate

Form	*white crystalline solid*
Melting point	*72-74°C.*
Solubility	*most organic solvents*

In an accelerated weathering test (ASTM D795-48) a 50 mil polyethylene film containing 1% OPS withstood 1,045 hours before the first sign of cracking, crazing or embrittlement (control value was 200). Good in polypropylene, too.

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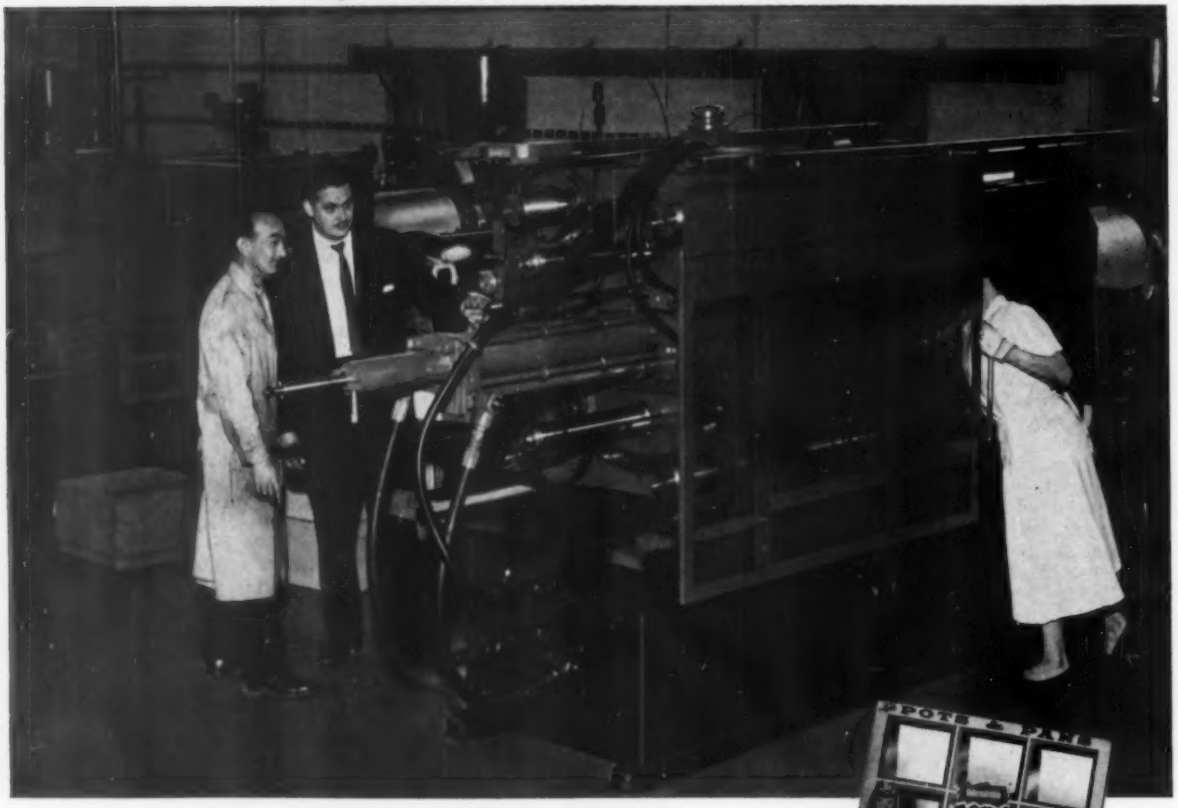

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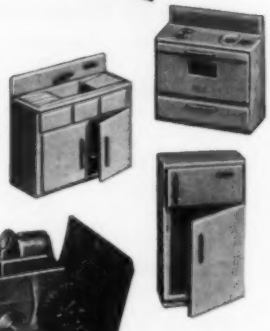

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Table VII: Properties of Oxiron wet lay-up laminates[a]

	Oxiron 2001	*Oxiron 2002*
Formulation		
Resin	100	100
Hexahydrophthalic anhydride	98	24
Propylene glycol	9.8	—
Maleic anhydride	—	24
Dicyclopentadiene dioxide	—	8
Varox liquid	—	2
Properties		
Flexural strength, 25° C., p.s.i.	82,500	76,440
Flexural modulus, 25° C., p.s.i.	3,500,000	3,310,000
Flexural strength, 71° C., p.s.i.	—	71,680
Tensile strength, 25° C., p.s.i.	64,150	51,330
Tensile modulus, 25° C., p.s.i.	3,700,000	3,600,000
Edgewise compressive strength, 25° C., p.s.i.	44,800	53,930
Edgewise compressive strength, 71° C., p.s.i.	—	57,800
Barcol hardness, p.s.i.	88	92

[a]Construction: 14-ply ⅛-in. laminate, Fiberglass cloth 181; type 136 finish with Oxiron 2001 and type 172 finish with Oxiron 2002. Cure cycle: for Oxiron 2001, 60 min. at 155° C. (311° F.) and 100 p.s.i. pressure; for Oxiron 2002, 45 min. at 110° C. (230° F.) and 150 p.s.i. pressure. Both laminates postcured for 4 hr. at 155° C. (311° F.).

curves for a conventional epichlorohydrin-bisphenol epoxy material (Resin A, Table VI) and an epoxidized polyolefin (Resin C, Table VI). Both resins have been cured with essentially the same cure agent except that the latter system included a peroxide to effect a cure through the double bonds. The results of tests run at 50 cycles and at various temperatures indicate a drastic loss of electrical properties, above 170° C. for the conventional resin, while the epoxidized polyolefin resin, even at 200° C., remains below 0.15. At 100,000 cycles (Fig. 7, right), both resins behave better but again the epichlorohydrin-bisphenol resin starts losing properties above 150 to 170° C. Even when this resin is cured with Nadic methyl anhydride, used in part because it imparts good high-temperature properties, a degradation sets in at 180° C., resulting in high electrical losses (curve for Resin E). Resin C again maintains good properties. Probably the fact that the cured epoxidized polyolefin shows stable (relatively unchanging) electrical properties over a wide range of temperature is more important than its absolute value.

Laminates

Epoxidized polyolefin resins lend themselves to laminate preparation by wet lay-up, match-die molding, premix, and prepreg procedures. Representative data are presented here for wet lay-up, prepreg, and printed circuitry laminates.

Wet lay-up. The lower viscosity resins 2001 and 2002 are best adapted to wet procedures. Table VII, below, presents data on properties of wet lay-up laminates prepared from these resins.

Prepreg. An ideal prepreg laminate is a dry storage-stable material with a residual tackiness or grab to facilitate lay-up. In practice, these materials may be stored several months, but then are required to flow and cure under laminating conditions at the place and time of use. Formulation of a reactive epoxy resin to achieve storage stability with good end laminate physical properties represents a considerable challenge. Storage-stable prepregs have been developed in our laboratories based upon a newly discovered proprietary curing agent, Oxiron Curing Agent 300. These are low-pressure laminates requiring 100 p.s.i. pressure at 155° C. (311° F.) to effect cure (Table VIII, below). The coated cloth is flexible, has good drape, and provides the proper tackiness to give "body build." Prepregs of this type have been stable in storage at room temperature for several months and stability tests are still in progress.

Printed circuitry. Laminates have been prepared with **(To page 198)**

Table VIII: Properties of Oxiron prepreg laminate[a]

Formulation	
Oxiron 2000	100 parts
Oxiron cure agent 300	35 parts
Tackifier (Bisphenol A)	15 parts
Properties	
Flexural strength, p.s.i.	80,450
Flexural modulus, p.s.i.	3,800,000
Tensile strength, p.s.i.	66,300
Tensile modulus, p.s.i.	5,000,000
Edgewise compressive strength, p.s.i.	55,000
Barcol hardness, p.s.i.	90
Peel strength of copper clad laminate[b], lb.	10.5 to 13.5

[a]Construction: 14-ply ⅛-in. laminate, Fiberglass cloth 181 with Volan A finish. Cure cycle: 30 min. at 155° C. (311° F.) and 100 p.s.i. pressure; postcured 4 hr. at 155° C. (311° F.). [b]ACC 2570, made by Rubber & Asbestos Corp.

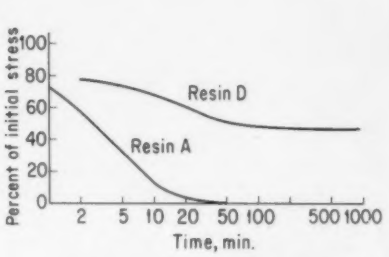

FIG. 5: Stress relaxation of epoxy resins at 155° C. Both resins initially stressed to 1680 p.s.i.

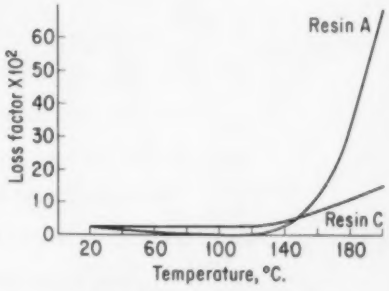

FIG. 6: Dielectric loss factor at 50 cy./sec. vs. temperature of epoxy resins.

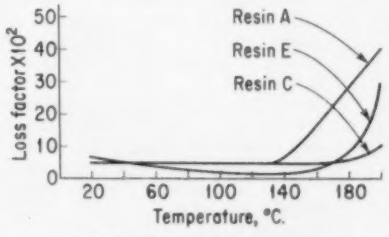

FIG. 7: Dielectric loss factor at 10^5 cy./sec. vs. temperature of epoxy resins.

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The Egan Extruder illustrated at right is a 4½" model with 24:1 L/D ratio.

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The heart of the improved Willert System is its AIR COOLED CONDENSERS, which are constructed of high pressure finned tubing and are located within the cylinder covers of the extruder. Individual zones along the cylinder are jacketed and connected to these condensers forming a closed system. Blowers are mounted in the base (see photo above) and, when in operation, remove the latent heat of vaporization. Therefore, excessive frictional heat is removed *automatically*, without thermal shock, providing uniform thermal regulation *regardless of viscosities or melt temperatures.*

The result is closer tolerance extrusions at greatly increased outputs.

Egan Extruders with the new Air Cooled Willert System are available in sizes from 2" through 12", with L/D ratios of 20:1, 24:1, 32:1.

Detailed information is available upon request.

Egan

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SOMERVILLE, NEW JERSEY

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NEW DEVELOPMENTS

Many minds at work on new ways to use plastics, new designs, and new product concepts offer ideas you can use.

Reinforced plastics move into agriculture

Old MacDonald is discovering that what works well in chemical processing does just as successfully on the farm . . . thus are reinforced plastics moving into the agricultural equipment market. Among the first applications are mobile spray tanks, stationary storage and feeding installations, and lime spreader tanks. And other equipment is on the drawing boards.

The reasons behind this trend are three-fold: corrosion resistance, light weight, and low cost. For example, an insecticide spray tank produced by Farmwell Co. Inc., Ixonia, Wis., provides the same advantages as stainless steel tanks—but at half the cost. These new tanks, made in 100-, 150-, 200-, and 300-gal. sizes, replace traditional 50-gal. oil drums, which rusted and scaled, clogging sprayer nozzles. The new tanks are trailer-mounted behind a tractor, and because of the greater capacities available, can now cover 10 acres per hour. The tanks are molded by Farmwell, using hand layup techniques.

In a similar application, John Deere Inc. has incorporated RP tanks (in 200-gal. size) on its No. 3¦ and No. 50 sprayers. The tank is produced by Molded Fiber Glass Body Co., Ashtabula, Ohio, in four parts: two ends and two body halves which overlap the end flanges. This construction permits a double thickness at the edges where the tank is most likely to get its hardest knocks. Weight of the tank is 55 lb., compared with 195 lb. for a comparable steel tank and 75 lb. for aluminum. The same tanks are used by Liquid Plant Food Co., Monrovia, Calif., in its irrigation system. The tanks are mounted on simple elevated platforms and feed liquid fertilizer by gravity into irrigation water.

INSECTICIDE SPRAY tank, mounted behind tractor, is molded of RP, has been found to withstand corrosive effect of spray chemicals.

CORROSION-RESISTANT dairy feed cart of glass-reinforced polyester is compartmented to hold grain, ensilage, and other ground or liquid feed, saves steps back and forth from feed bin or silo to individual animal's stalls.

LIME SPREADER for dairy sanitation is produced by hand lay-up of reinforced polyester, is easier to handle than metal equivalent because its weight is much less.

Embedment with plastisol saves 35 percent

In producing the Filtronic air filter, material and assembly costs are reduced 35% by the use of molded-in-place vinyl plastisol for embedment and sealing of the filter element.

The filter, manufactured by Fram Corp., Providence, R. I., has a pleated paper element which must be held securely in place, top and bottom, and gasketed against air leakage. In the former production method, four separate steps and materials were required: 1) fabrication of a stamped metal ring; 2) fabrication of a cut rubber gasket; 3) adhering of paper element to metal ring; and 4) adhering of gasket to metal ring. The plastisol compound that is now used is Chem-o-sol, manufactured by Chemical Products Corp., E. Providence, R. I. It is specially formulated to be fast-fusing and to resist wicking, high temperatures, and gasoline fumes. The former metal ring and the paper-to-metal adhesive is eliminated, also the cut gasket and its adhesive, since the plastisol serves as a gasket between the filter and metal silencer.

At the Fram plant, the pleated paper element is inserted between a perforated metal outer shell and an inner wire screen. Chem-o-sol is flowed into a low-profile ring mold, the assembled filter parts placed into the mold, and the entire unit conveyed at a controlled rate through a fusing oven.

When fusion is completed, the unit is taken from the oven and inverted. The ungasketed filter end is placed into a second ring mold, which has been filled with the liquid plastisol. Oven fusing is repeated, the unit again removed from the oven and air cooled, the molds stripped off, and the completed filter inspected and readied for shipment.

(More on next page)

EMENEE juke box is shown at left with its styrene sheet components. Base and cowl-like hood are vacuum formed two at a time from single sheets, then cut apart.

JR. JUKE of Shell Electronics also uses two-piece construction of styrene sheet. Finished toy stands 36 in. high, 21 in. wide, and 15 in. deep.

Juke boxes from styrene sheet

Two of the best selling "big toy" items today, both notable examples of the art of vacuum forming, are the miniature juke boxes sold by Shell Electronics, Westbury, N.Y., and Emenee Industries, Flushing, N.Y.

In both applications, impact styrene sheet with high-gloss finish was selected for rigidity, impact strength, economy, light weight, and surface attractiveness. The juke boxes, designed for the younger set, are realistic-looking right down to selector buttons and colored lights.

The Shell Electronics toy, which sells in a $33 to $40 range, is vacuum formed by Chanal Plastics Corp., Rego Park, N. Y. Total weight of the plastic parts, the base, and a canopy top, is just over 4 lb., and the finished toy measures 36 by 21 by 15 inches.

The top is formed from 105-gage white sheet on a standard, single-heater machine. However, in a variation of the snap-back forming process, Chanal uses partial vacuum to draw the heated sheet into a vacuum box, then raises the sheet up against the mold by means of a hydraulic cylinder to which the sheet clamps are attached. Reason for the process reversal was that the aluminum-filled epoxy mold was too heavy for constant up and down movements. Vacuum is pulled through the mold, and the sheet drawn to a depth of 12 inches. Forming temperature is 1300° F., cycle about 2 minutes.

The base is produced by snap-back forming of 137-gage red styrene sheet on a rotary, sandwich-heater machine manufactured by Comet Industries, Franklin Park, Ill. Depth of draw is 15 in., forming temperature about 1600° F., and forming cycle approximately 1 minute.

The Emenee juke box, which carries a list price of $49, is vacuum formed by Plastic Enterprises, College Point, N. Y. Dimensions of this product are 34½ by 21½ by 15 in., and there are two basic sections, top and base.

The base and top are snap-back formed using 135-gage, turquoise-pigmented styrene sheet and 105-gage white stock respectively. Forming is done on a sandwich-heater machine manufactured by Auto-Vac Co., Bridgeport, Conn. After the sheets are heated, a bubble is partially drawn into a vacuum box and the cast aluminum mold is lowered. Vacuum is then applied to the mold, the vacuum box exhausted to atmosphere, and the sheet snaps back and forms against the mold. Depth of draw for the juke box housing is 15 in. for the base, 12½ in. for the top, and forming cycle for both parts is about 1½ minutes.

Nylon rolls save $2000 per machine annually

By replacing kraft paper back-up rolls with rolls of MC Nylon, Royal Lace Paper Div., Standard Packaging Corp., Fort Wayne, Ind., found a way to substantially reduce the cost of die cutting paper place mats and lace paper doilies. Savings in the cost of rolls alone are $2000 per machine annually. In addition, machine down time is reduced, less scrap is produced, and the quality is improved.

MC Nylon is a new nylon recently introduced by The Polymer Corp., Reading, Pa., for large symmetrical shapes. Rolls in the Royal Lace application are 5-in. I.D. by 7-in. O.D. by 13 in. long and function as backing for the engraving rolls. During the die cutting operation, paper passes between the knife edges of the engraving roll and the nylon roll.

Previously, kraft paper rolls were used for this purpose. In making these rolls, kraft paper disks were first die cut with a central shaft clearance hole. Thousands of these disks were then compressed in an hydraulic arbor to form the roll and the mounting shaft and metal end plates applied. The roll was then mounted in a lathe and the surface machined to the desired size and smoothness. Although basic material was inexpensive, the labor involved brought the cost of these kraft paper rolls to $40 each.

There were operational disadvantages, too. The paper rolls, for example, marked under the action of the sharp knife edges. The rolls, therefore, had to be resurfaced by scraping several times during the day. Material running through the machine during this redressing operation had to be discarded as scrap, since the brown kraft paper shreds would incorporate into the goods and spoil it. The average life of these kraft paper rolls was as short as one week.

The nylon rolls, in contrast, are slightly higher in initial cost. Polymer's present price on the new nylon formulation is approximately $50 for the 7-in. O.D. tubular bar. But in design and use of the rolls, there is much to offset the extra cost. First of all, there is little additional labor in making the rolls. The nylon is simply heated to expand it slightly. It is then slipped onto an arbor. The shrink fit provides adequate adhesion between resurfacings.

Whereas the paper rolls must be resurfaced several times a day, the nylon rolls operate a minimum of a month, and frequently much longer, between resurfacings.

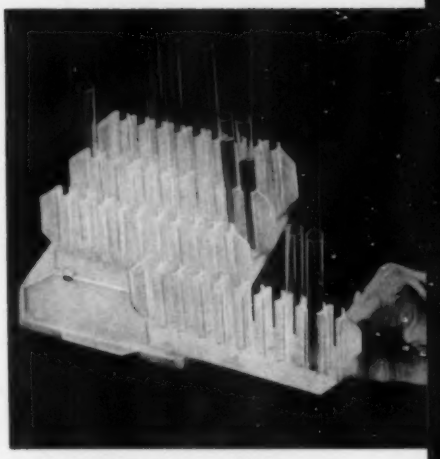
Based on the present life of the nylon rolls, one nylon roll outwears 50 paper rolls costing $40 each.

Quality of the die cutting is improved, too. As back-up rolls mark under the influence of cutting dies, the action changes from a cutting to tearing. Tearing produces a shred on the edge rather than a clean edge. Paper back-up rolls go through this cycle from clean cutting to shredded edges several times a day. The resilient nylon rolls, on the other hand, resist marking and practically eliminate this cyclic effect on quality.

Test tube rack of high-density polyethylene

Engineered around the design potential of polyethylene, an all-PE test tube rack manufactured by The Nalge Co. Inc., Rochester, N. Y., incorporates the "finger-holding" principle which assures complete visibility of test tube contents at all times. The rack consists of two parts: the base and the sliding support. Both units are injection molded of Solvic (a Phillips-type) high-density resin in Italy on 6/8-oz. Reed-Prentice machines. Tools are presently being cut for molding the rack in the United States. When completed, the item will be molded for Nalge by Ontario Plastics Co., Rochester, N. Y. Molded into the base are ridges and lugs that provide a "track" for the sliding support. Handles molded into the side of the base facilitate carrying. The supports are available as free-standing units with capacity for nine 14- to 17-mm. or ten 12- to 15-mm. test tubes. Bases are designed to hold two to four supports. Test tubes are held by "pockets" designed in the form of cylinders open on two sides. The support is easily removed from the base, without disturbing any additional units that remain on it. Close tolerances assure the slide-to-base fit that prevents the slide from slipping out of the base if the latter is tipped. At the same time, polyethylene's low coefficient of friction makes the gliding action easy.

The chemical resistance of the resin and the fact that it can safely withstand immersion in boiling water, make these racks highly suitable for today's labs. According to Nalge, which holds the North American rights for the unit, these racks will considerably outlast wooden and metal equivalents. Cost is $1.95 for the double-base tube rack. This compares with approximately $1.30 to $2.95 for equivalent wooden racks or about $2.50 to $4.50 for coated metal unit.



RACK for test tubes, molded of chemical-resistant high-density PE, may be used as free-standing unit or slid into groove-track bases which hold two or four racks. Low coefficient of friction of PE makes sliding action easy.

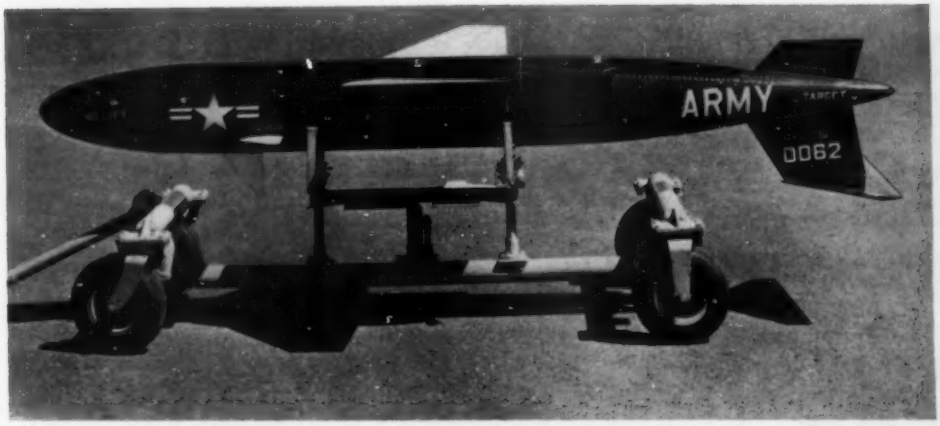
Reinforced plastics missile components

Because of their lightweight durability and reusability, reinforced plastics nose and aft fuselage sections have proved highly successful in the U. S. Army's RP-76 (RP for rocket powered) target missile. The plastics parts not only insure quick ground recovery, but also enable the drones to be reused if the target is not intercepted in flight.

Other reasons why the contractor—Radioplane Div. of Northrop Corp., Van Nuys, Calif.—selected RP for the drone: 1) outstanding electrical properties, which make the plastic material transparent to radar beams, thereby permitting unobstructed reflections from the Luneberg radar augmenter in the nose; 2) resistance to extreme temperatures (above 200° F.); and 3) unusual weathering protection.

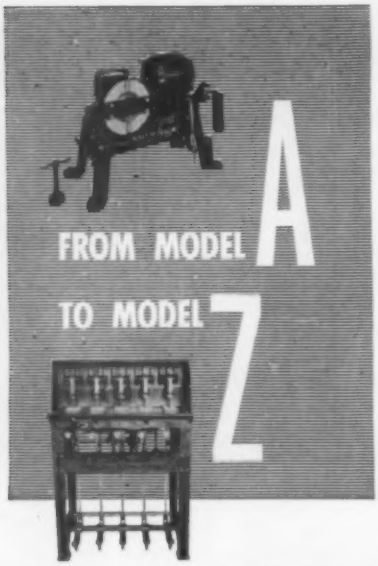
The missile's two plastics sections (see photo below) which are attached to the center steel case housing the solid propellent rocket engine, are molded with Mobaloy D prepregs (supplied by Cordo Chemical Corp., Mobile, Ala.) that are impregnated with Dapon diallyl phthalate resin, a product of Food Machinery & Chemical Corp., New York, N. Y. Made tacky to facilitate hand lay-up for match-die molding, the DAP-reinforced glass cloth is said to offer good shape and excellent resin flow during cure. And the maroon color of the parts is incorporated in the resin, thereby eliminating the need for painting.

Measuring 9 ft. 8 in. in length, the drone has reached an altitude of 75,000 ft. in tests at the White Sands Missile Range, N. Mex. It has been intercepted at heights up to 55,000 feet.



TARGET MISSILE uses nose cone and tail section (photo, right) of reinforced plastics. Resistance to high temperatures of supersonic flight and strength which permits ground recovery if target is not destroyed are among reasons for choice of RP for these components.

(More on next page)



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NEW DEVELOPMENTS *(From page 149)*

Metallized polyethylene squeeze bottle

New glamour has been added to the polyethylene squeeze bottle as a result of a unique new metallizing technique developed by Poly-Kote Inc., North Attleboro, Mass. Bottles and other polyethylene objects can now be given a metallic finish in either the conventional silver or gold colors or any one of a whole range of other colors. The coatings have an attractive wrinkle finish as is shown in the illustration below, giving the bottle or item a rich nugget like quality. A special polyethylene surface

pre-treatment provides excellent adhesion of the coating to the plastic surface. The coatings can be flexed more than 400 times without cracking or peeling, it is claimed. The finish will also take any type of printing or silk screening inks and is compatible with most glues used for applying labels.

A big advantage claimed for the decorative coating is the ability to decrease the permeability of the polyethylene bottle. In a test with alcohol in a 4-oz. bottle, it was possible after 4 months to pour out 58 cc. out of an original charge of 60 cc. of alcohol. Another tough material to contain in polyethylene bottles, acetone, showed a sharp decrease of vapor loss in the metallized bottle. Because of the improved resistance to permeability and the colorful glitter of the bottles, they are expected to find wide use in the cosmetics packaging field. Another suggested use for the coatings is the manufacture of blow-molded Christmas tree ornaments, which could also do double duty as premium packages.

Total coating thickness runs about 4 mils, consisting of a base coat about 3 mils thick, a layer of aluminum about 0.8 microinch thick, and a top coat about 1 mil thick. Cost of the coatings is competitive with the costs of other metallized finishes. However, the coatings weigh relatively little; thus they do not appreciably increase the shipping costs of such bottles and, of course, retain the shipping cost advantage of a plastic bottle over bottles of glass and other materials.

. . . And in brief

• Power driven fishing reels for deep-sea fishing are using gears machined from extruded Delrin acetal rod stock supplied by National Vulcanized Fibre Co., Wilmington, Del. The reels, made by Reelmaster Inc., San Antonio, Texas, make "pushbutton" fishing a practical reality for salt-water anglers. The machined acetal gears outlasted steel gears by far in actual use tests, and they cost only one-quarter as much because of the ease of machining the plastic material.

• Reinforced PVC sheeting is being offered under the tradename Plastolene by Storeys of Lancaster, England. Produced by laminating specially constructed polyester fabrics between two layers of PVC sheeting, the resulting material is claimed to have not only a high strength/weight ratio, but also to offer an unusually attractive appearance which can be "tailored" to specifications by varying the weave of the center ply of the laminate.

• Completely transparent epoxy castings can now be easily made in flexible, or high-impact as well as rigid form, using crystal-clear Maraglas resin and suitably proportioned hardeners, according to Marblette Corp., Long Island City, N. Y. Casting is done by simple pouring; cure is at 180 to 210° F. for several hours. Light transmission of 90% is claimed.

• Colored phenolic laminate bobbin barrels are being offered to the textile mill trade for speeding production and reducing workman errors through the use of permanent codes based on the barrel colors. The bobbin barrels are being offered by Taylor Fibre Co., Norristown, Pa., in both paper and cotton-fabric base grades of laminate. Colors available include natural, red, green, yellow, blue, and black.—**End**

VINYLS • POLYOLEFINS • ACRYLATES • EPOXIES POLYESTERS • URETHANE FOAM • POLYSTYRENE

In recent years, antimony oxide has found greatly increased use as a flame retardant in a wide range of flammable materials—particularly plastics. Polyolefins, polystyrene, vinyls, polyesters, acrylates, epoxies and urethane foams are among the plastics in which antimony oxide has been used to provide the necessary degree of safety for consumer products.

A bibliography, "Reported Uses of Antimony Trioxide as Fire and Flame Retardant," has been compiled by M&T and is available on request. Offered by M&T are grades of antimony compounds specially made for these applications. Particularly interesting is their range of opacity, permitting optimum formulation when color and appearance is a consideration. Send for technical literature on THERMOGUARD*H, THERMOGUARD*L, and M&T Flame Retarder. These three antimony-based compounds offer a wide range of tinctorial strengths. *Trademark

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LITERATURE

Write for these publications to the companies listed. Unless otherwise specified, they will be sent gratis to executives who request them on business stationery.

"Block and Graft Polymers," *by W. J. Burlant and A. S. Hoffman*

Published in 1961 by the Reinhold Publishing Corp., 430 Park Ave., New York, N. Y. 166 pages. Price: $7.95

A bonus feature of this book is its excellent readability. Included in this qualitative summary of the art, are the reactions and experimental methods used for the initiation of block and graft polymerizations and a discussion of the available knowledge on the structure of the resulting polymer products and their physical properties. As the preface so aptly puts it, "Its purpose is to suggest to scientists and engineers in the plastics field, who are interested in new materials, that 'molecular engineering' of polymers—the synthesis of macromolecules of known configuration and physical characteristics—is indeed possible." Plastic product engineers and chemists will find the book an excellent "first text" on this timely subject of growing importance—*G.R.S.*

Blow-Up Ratio in Blown-Film Making includes formulas and a chart for determining blow-up ratio and blown-film width. Chart assists film extruder in determining at what blow-up ratios he must operate to obtain specified blown-film widths with given extruder die diameters. Data Sheet PTD-25. 2 pages. *U. S. Industrial Chemicals Co., 99 Park Ave., New York 16, N. Y.*

Vinyl stabilizers. Properties, description, applications, and similar data on the stabilizing of all forms of vinyl products, including rigids, flexible vinyls, plastisols and organosols, expanded vinyls, homogeneous tile, and asbestos tile. 40 pages. *Ferro Chemical, div. of Ferro Corp., P. O. Box 349, Bedford, Ohio.*

Thermosetting phenolic resin. "For the Foundry Industry" presents technical data on SP-7412, a pulverized, thermosetting phenolic resin developed specifically as a high-bonding resin for shell mold assembly. 4 pages. *Schenectady Varnish Co. Inc., Schenectady 1, N. Y.*

Machining laminated plastics. Lists recommended speeds and feeds for circular sawing, band sawing, turning, and boring, threading, automatic screw machines, drilling, milling, gear cutting, punching, and special considerations for glass-base grade of Lamitex. Also lists tool sizes and cutter types. 2 pages. *Franklin Fibre-Lamitex Corp., 129 Lafayette St., New York 13, N. Y.*

Encapsulating, plastics molding. Specifications, features, and uses for a line of production systems for potting, encapsulating, molding plastics, urethane foaming, impregnating, etc. Applications specifically for electrical and electronics industries. Bulletin E-1160. 4 pages. *Hull Corp., Hatboro, Pa.*

Hopper Car Handling of Plastics Products describes the engineering techniques employed by seven major manufacturers of bulk handling plastic resins in hopper car quantities. 24 pages. *Monsanto Chemical Co., Plastics Div., Springfield, Mass.*

Carbide-tipped saws and tools. Handbook lists complete line of carbide-tipped blades and tools available, including rip, cross-cut, thin-rim, and hollow-ground saws. Blade Selector shows which blade to use for every type of material and cutting condition. 20 pages. *Victory Carbide Saw & Tool Co., 1027-41 Anita Ave., Antioch, Ill.*

Expandable polystyrene. Outlines the applicability of regular and self-extinguishing Uni-Crest expandable and expanded polystyrene for construction, refrigeration, air conditioning, flotation, and packaging. 8 pages. *United Cork Companies, Kearny, N. J.*

Plastics Molding Machinery illustrates a line of horizontal and vertical injection molding machines, compression and transfer molding presses and laboratory and general-purpose presses. Bulletin 600. 12 pages. *Farrel-Birmingham Co. Inc., Watson-Stillman Press Div., Rochester 10, N. Y.*

Laminated sheets, rods, tubing. Grades, features, strength, water absorption, resistivity, dielectric constant, uses, and other technical data for laminated plastic sheets, rods, and tubing used in electrical and electronic fields. 18 pages. *Panelyte Div., St. Regis Paper Co., Trenton 8, N. J.*

Pigments. Properties, typical uses, problems of orientation and techniques, etc., for a line of pigments for plastics, coating, and cosmetic industries. 16 pages. *Rona Pearl Corp., East 21 and 22nd Sts., Bayonne, N. J.*

PVC plastisol resin. Features, applications, etc., for Marvinol VR-53, a PVC plastisol resin for slush molding, vinyl foam, and general compounding. 4 pages. *United States Rubber Co., Naugatuck Chemical Div., Naugatuck, Conn.*

Automatic temperature control. Specifications, features, and uses for a line of automatic temperature control equipment for injection molding, blow molding, vacuum forming, film extrusion, and laminating. 6 pages. *Sarco Co., Inc., 635 Madison Ave., New York 22, N. Y.*

Acetal resin. "This Is Delrin Acetal Resin" discusses properties, design considerations, forming techniques, examples of its applications, and similar aspects. Booklet A-18404. 23 pages. *E. I. du Pont de Nemours & Co. Inc., Wilmington 98, Del.*

Epoxy resins. Features, applications, properties, working instructions, etc., for Maraglas transparent epoxy resin. Sample kit of resin, hardener, and accessories sells for $6. Bulletin 655. 2 pages. *Marblette Corp., 37-31 Thirtieth St., Long Island City 1, N. Y.*

Polystyrene and polyethylene foams. "A Guide to Design of Floating Structures with Styrofoam" presents property data and applications, including a summary of flotation uses. Similar data for Ethafoam PE foam. Bulletin A.I.A. 32-B (NN). 24 pages. *Dow Chemical Co., Plastics Sales, Midland, Mich.*

Nylon. "Injection Molding with Nylatron GS Nylon" discusses molding equipment, mold design, material preparation, molding operation, post treatment of parts, etc. Bulletin T-1a. 20 pages. *The Polymer Corp., Molding Resins Div., Reading, Pa.*

Plastics as an Engineering Career is an 8-page guide for the student or others interested in the plastics industry. *Society of Plastics Engineers Inc., 65 Prospect St., Stamford, Conn.*

Trade Practice Rules for the Fluorocarbons Industry contains the rules as promulgated by the FTC on Jan. 11, 1961. 20 pages. *Federal Trade Commission, Bureau of Consultation, Washington 25, D. C.* or regional offices of FTC.—**End**

with the

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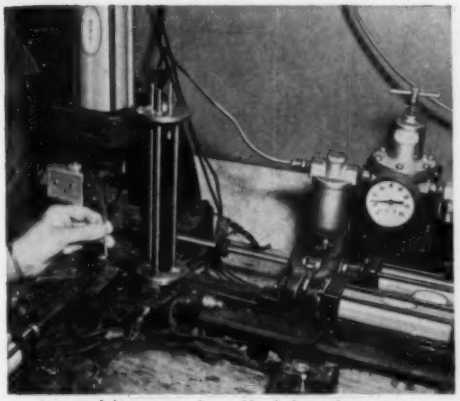

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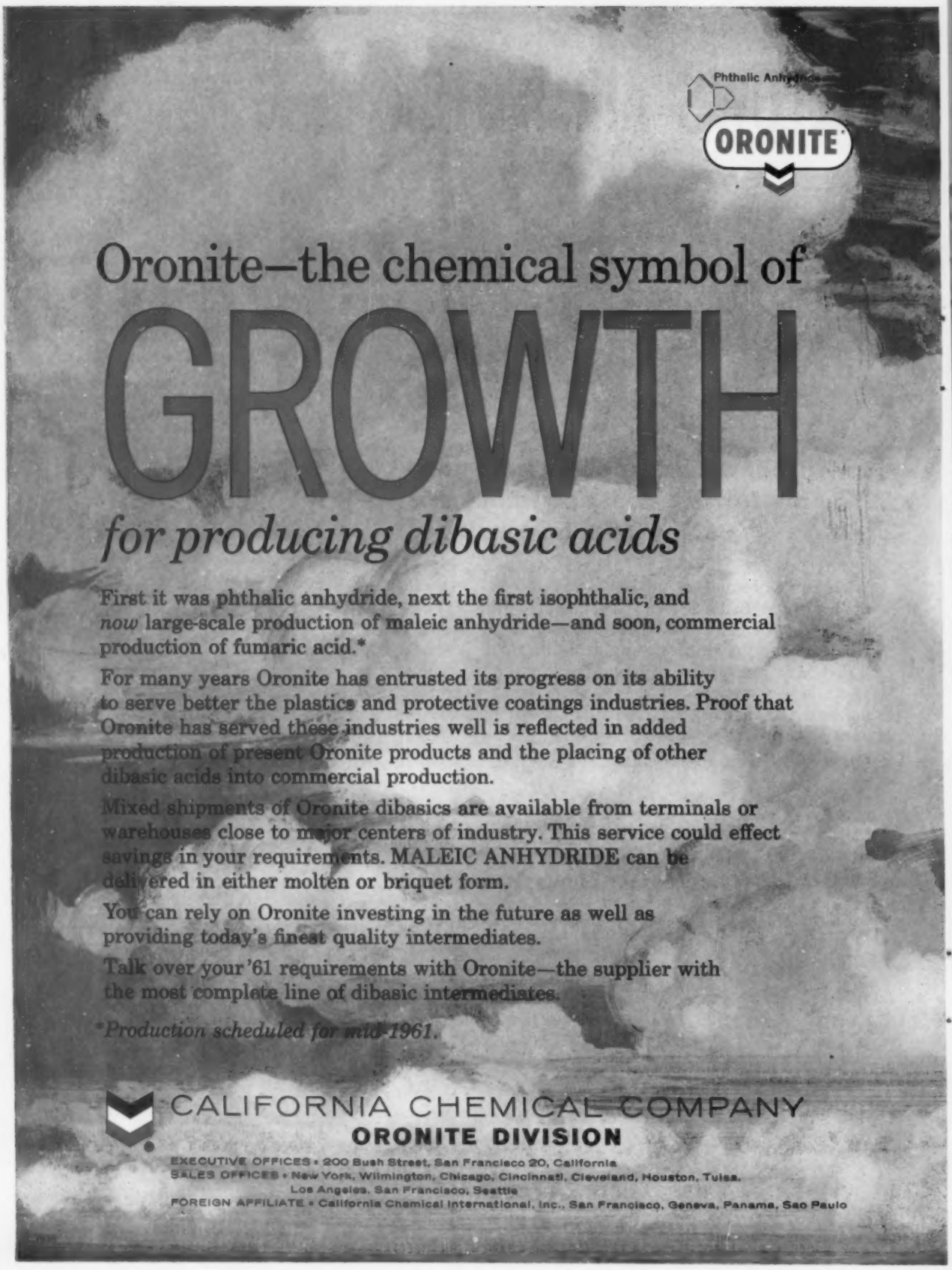
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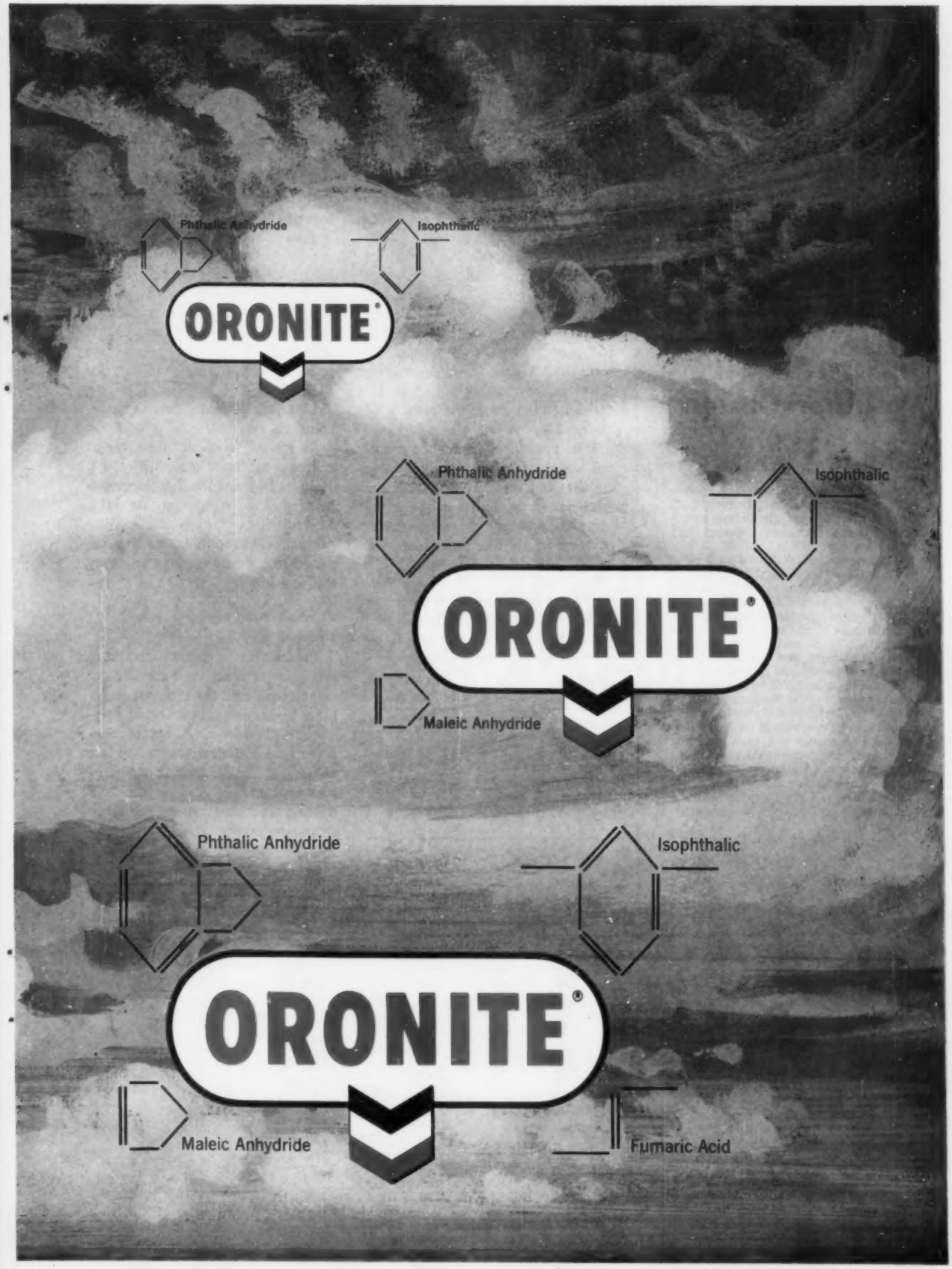
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Where is ABS headed?

(From pp. 82-86)

sent a potential of about 330 million lb.; quite a bit away from the ½-billion-lb. prediction. There is, however, one other major potential market which could bring the total ABS potential above 450 million lb. by 1965. The market is packaging. Experimental film has already been produced, and in 1-mil thicknesses is relatively transparent; blow molding looks promising, and there are several companies on the verge of making public announcements concerning ABS blown bottles—in Europe, one line of lighter fluids has been sold in such bottles for some time. Work is even in progress in several of the labs aimed at doing something about the opacity of the material.

It is generally felt by the material suppliers and by several blow molders that the likely market for ABS bottles would be in the packaging of powdery materials (talcs, etc.), especially where the customer requires a hard surface—which would apply, for example, to men's toiletries. The greater stiffness of ABS as compared to PE would help make the materials more nearly competitive: with ABS, less material would have to be used; faster processing speeds would result from the thinner wall sections; in turn this would mean faster cooling . . . and cooling represents a major portion of the blow-molding cycle.

And then, of course, there are the unexpected applications that keep cropping up. For example, one of the hottest selling dolls during the 1960-1961 Christmas season was a number called Chatty Cathy. Hundreds of thousands of them must have been sold, all molded of ABS.

Last year also saw the announcement of two dramatic application firsts for ABS: a giant refrigerated railroad car door (see MPI, Sept. 1960, p. 94), and the first American plastic-housed typewriter (see MPI, May, 1960, p. 92). The most important 1961 applications are depicted in the photos accompanying this article.

Table I: Growth markets for ABS pipe[a]

Application	*Potential million ft./yr.*
Gas distribution	107
Water services (municipal, pool, etc.)	95
Conduit	58.5

A wide range of properties offered

Because the largest component in ABS is styrene, end-users have often considered the material as another higher-impact version of polystyrene. However, designers concerned with material selection are coming to realize that in terms of many properties ABS is an engineering-type plastic more related to nylon, polycarbonates, acetals, cel-

Table II: Municipal service pipe costs: ABS vs. asbestos-cement[b]

ABS				*Asbestos-cement*				
Size	*Net price per ft.*	*Inst'n per ft.*	*Inst'd cost per ft.*	*Size*	*Net price per ft.*	*Inst'n per ft.*	*Inst'd cost per ft.*	*Savings per ft.*
in.	*$*	*¢*	*$*	*in.*	*¢*	*¢*	*$*	*¢*
				100 p.s.i.				
3	57	20	0.77	3	81	38	1.19	42
4	90	20	1.10	98	39	39	1.37	27
6	2.06	22	2.28	6	148	43	1.91	—37[c]
				150 p.s.i.				
3	81	20	1.01	3	87	38	1.25	24
4	1.24	20	1.44	4	105	40	1.45	0.1
6	2.68	22	2.90	6	163	44	2.07	—83[c]

a, [b]From a study made by U.S. Rubber Co., Naugatuck Div. [c]Net loss in cents per foot.

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lulosics, and impact acrylics, than to the polystyrenes. Compared to the big three—polyethylene, vinyl, and polystyrene—it is also a premium-priced plastic. And while ABS prices can be expected to go down gradually over the next five years, they will always be significantly higher than that of the three mass resins—most observers foresee a price level for ABS by 1965 at 29¢/lb.; current prices range from 41¢ to 60¢ per pound.

When ABS resins started to grow significantly about six years ago, only a limited range of formulations was available, and the two suppliers then in the market were producing different materials.

Marbon Chemical, Div. of Borg Warner, was marketing a material that it termed a terpolymer of styrene, butadiene, and acrylonitrile; U. S. Rubber was selling a physically mixed blend of styrene-acrylonitrile and acrylonitrile-butadiene (nitrile rubber). But even then, Marbon Chemical's resin was not a one-phase system. The company was producing a graft polymer by over-polymerizing polybutadiene. The remainder becomes part of a physical mix.

Today, however, all ABS materials are two-phase systems, consisting of two or more of the following copolymers: butadiene-acrylonitrile, styrene-acrylonitrile, graft or block terpolymers and/or other complicated polymer structures possible with this monomer system. The exact production techniques which the various companies use differ, and are closely guarded secrets; however, they have one thing in common: the streams can be varied as to the proportion of the three materials so that a wide range of properties can be formulated.

Monsanto spokesmen, for example, state that this is the route along which their company entered the field. They looked at the markets they meant to serve, then went ahead and formulated resins to meet the indicated requirements.

Altogether, there are currently 23 standard formulations available to industry with the following property ranges:

Impact strength: 0.8 to 9.5 (Izod, ⅛-in. sample, notched 73° F.). This value is higher than that of about 75% of all plastics materials, and exceeds such metals as red brass, magnesium alloys, some tin-bronze, and lead-tin-antimony.

Flexural modulus: 190,000 to 450,000 p.s.i. (This is a measure of stiffness, the higher the number, the stiffer the material.)

It is probably the combination of these two properties that makes ABS such a standout. There are thermoplastics that are stiffer . . . but their impact strength is lower; there are thermoplastics that have higher impact strength . . . but their stiffness is less.

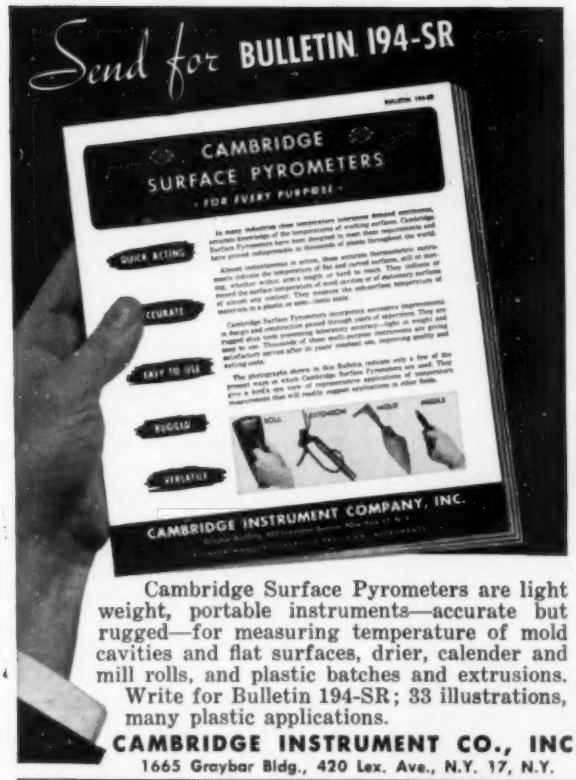
Hardness: Rockwell R74 to R116. (This is a measure indicative of scratch resistance; the higher the number, the harder the material.) Again, there are some thermoplastics that are harder, particularly nylons and acetals; however, their impact strength is appreciably lower.

Processability: Here ABS resins can bring real economies to the molder or extruder. As a rough indication it might be stated that they process about as readily as high-impact polystyrene on injection-molding and extrusion machines. Some ABS resins are formulated for calendering into sheet material. They make up easily in the Banbury, band readily on the mill, and require only the usual amont of lubrication for release from the calender rolls.

Blow molding is feasible and several experimental containers have been produced in the United States. There are persistent rumors that several companies are market-testing oil packaged in blown ABS bottles; there are also rumors that one small-appliance maker is blowing an ABS housing for a hair dryer. However, no confirmation has been obtained as of this writing. But, there is no question, however, that the material can be blown.

Machining, cementing, fabrication, and decorating operations follow conventional plastics techniques. However, dry coloring requires Banbury-type blending and, except for the largest plants, is generally not feasible for the processor.

Opacity: Unlike polystyrene and styrene copolymer resins, ABS materials are opaque, even in fairly thin sections. (However, 1-mil film such as has been produced experimentally shows a modicum of transparency, although not approaching the crystal clarity of styrene, or



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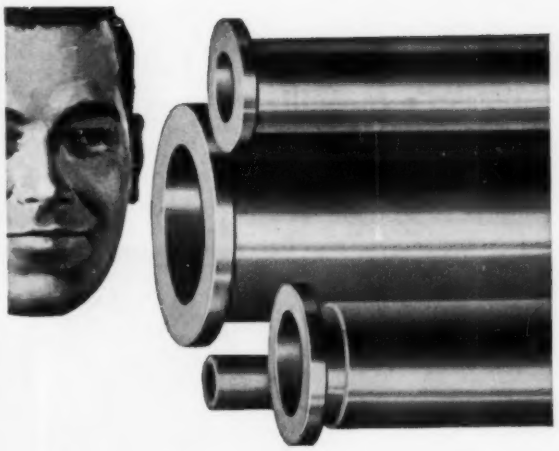

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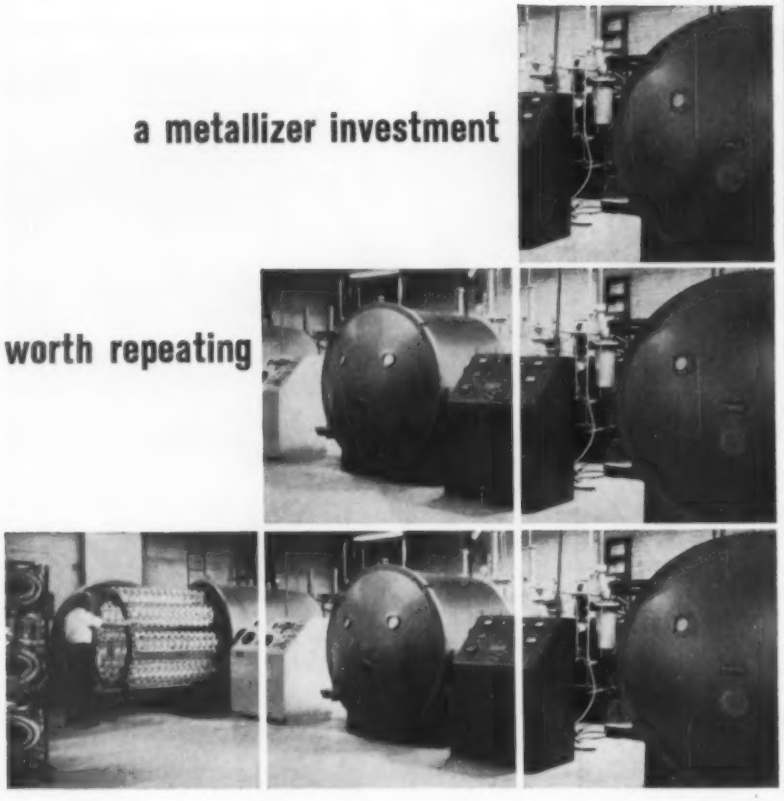

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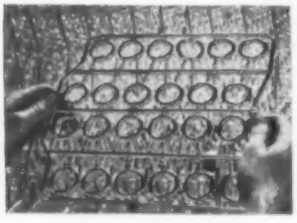

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STOKES

even the light transmission that is inherent in chill-roll cast polyethylene resins.)

As the resin is made today, opacity is inherent in the formulation. However, most suppliers are actively at work on efforts to produce some degree of translucency, and perhaps transparency. The problem today lies in the fact that current ABS resins are two-phase systems in which the refractive index of one does not match that of the other. And as long as that situation persists, opacity will remain a characteristic of ABS. But if transparency can be achieved, the packaging market would become a prime ABS target. Some ABS materials have "prior sanction" exception from the regulatory provisions of the Food Additives amendment, and presumably all types can be formulated to meet FDA's present requirements.

Space does not permit consideration of all properties in detail. Every material supplier has a full list of specifications; and the reader is advised to contact them for specific details. However, it should be pointed out that, as at present formulated, the material is flammable. Work is in progress to make ABS self-extinguishing. In the meantime, an intumescent coating sprayed on inside surfaces is reportedly meeting with Underwriters' Laboratories acceptance, and is currently being used in a number of appliance housings.

Price: There have been various price peregrinations in ABS during the past few months. During one week recently, pipe resins tumbled 2 to 4¢/lb. to reach a low of 44¢/lb. for Type I. (Type IA went down to 47¢, Type II to 54¢/lb.) Then, too, Monsanto's entry into the field brought an entirely new aspect to the ABS price structure. Up to that time, all ABS molding grade resins sold (recently) at 51¢/lb. (colored). Two of Monsanto's formulations were also introduced at this price. But two others were brought in at 41¢/lb. and 45¢/lb., respectively (colored)—which is below the price for styrene-acrylonitrile resins. Generally speaking, Monsanto's prices vary with impact strength and prices of all makers with chemical resistance and stiffness.

Per-pound prices, of course, are only part of the story. Cost per

cu. in. is of more significance, here is how various materials stack up.

Material	*Cost/cu. in. (¢)*
Polyethylene	0.86 to 1.35
Acetal	3.34
Methacrylate	2.34
Nylon	4.04 to 4.95
Polystyrene	0.69 to 1.04
Polypropylene	1.36
Impact acrylic	1.88
ABS	1.51 to 1.88
Rigid PVC	1.25 to 2.00
Acetate	2.02
Butyrate	2.67
Propionate	2.71
Polycarbonate	5.63

Even price per cu. in. is not the whole answer. Stiffness and strength must also be taken into account. For instance, a stiff material will generally require a thinner wall (therefore, less material per projected area) than a soft material to produce the same degree of rigidity in the molded piece.

As to the future, there is general agreement—though not always stated publicly—that ABS prices will continue to decline gradually. The most frequently heard estimate is that this decline will be on the order of 33% and that the price will level off in the range of the high twenties and low thirties. That is, provided anticipated sales volume is largely realized.

As they are poised for a major volume breakthrough, ABS materials offer new opportunities to the design engineer and the end-product manufacturer. They provide a broad range of properties that will make them increasingly a replacement material for cast metal and other conventional materials of construction. Already in the blueprint stage are such applications as fan blades, transmission covers which will reduce car weight by many pounds, interior paneling for transportation use, rustproof fender liners and one-piece inner door liners for cars, and blow-molded industrial housings. As volume of use increases and as price comes down, additional, more tailor-made formulations can be expected. Thus it will be possible to design most carefully for the application involved—to eliminate costly over-design as well as ruinous under-design. And given a material that is just right for the job, how can the manufacturer miss?—**End**

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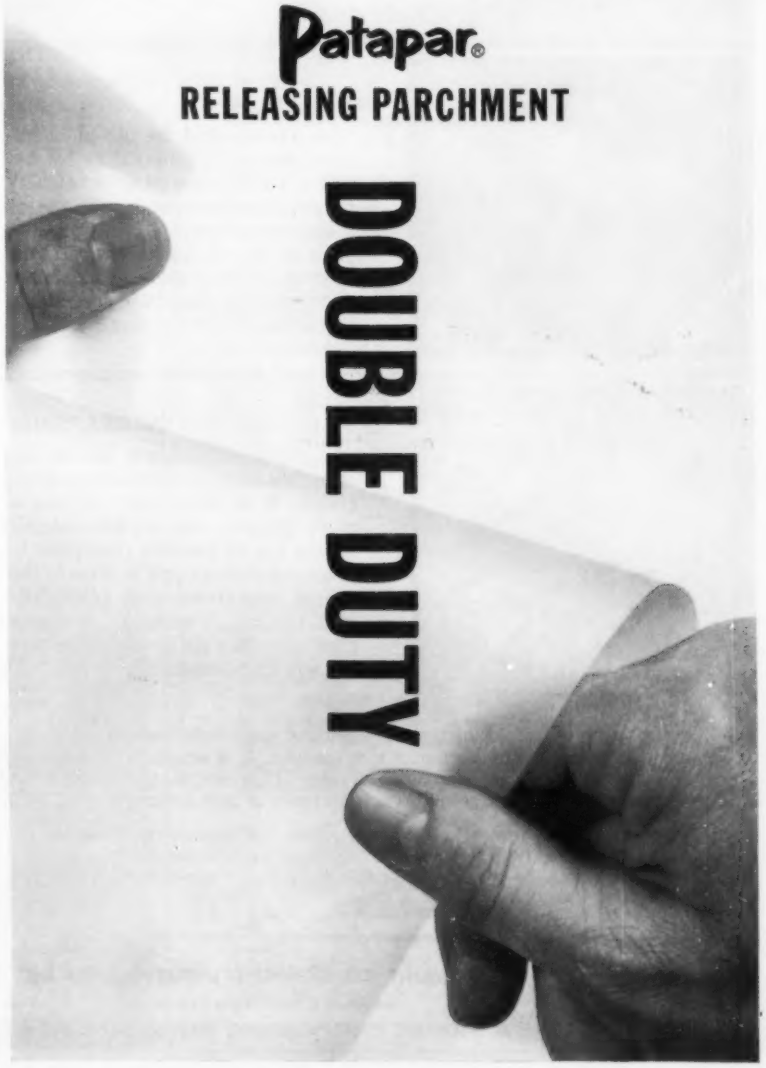

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Door hardware

(From pp. 88-89)

economics of injection molding, which permits a reduction in the number of total parts with consequent reductions in assembly cost. In one set of internal parts, for example, two nylon moldings replaced 11 metal parts.

The reception to the new locksets by the building field has been encouraging. In fact, several construction firms are making the use of such locksets in their buildings part of their sales promotion. Others have pasted labels on the door in order to draw attention to the new locksets.

Lockwood Hardware views this entire development as somewhat paralleling the history of plastics in automobiles: slow initial acceptance, but rapidly growing usage once performance has been firmly established.

Nylon spindles; urea knobs

A less complicated, but equally significant, design problem was solved by Travco Plastics Co. Inc., Brooklyn, N. Y.: how to improve on standard replacement door knobs—in terms of performance, price, and appearance—through the use of plastics.

Conventional door knob sets, using threaded metal spindles and metal knobs, retail for 79¢ (plated steel) and $1.29 to $1.49 (solid brass). Their shortcomings: steel plating usually wears off, the metal slowly corrodes, and the thread on the spindle wears rapidly, making the knob wobbly. Both problems were solved by specifying nylon-6 for the injection molded spindle, and urea for the compression molded knobs.

The nylon spindles have molded-in slots on each side (see photo, p. 89) that permit installation in a range of door widths. There are no threads. Instead, to install it, the knob is simply slipped onto one end of the spindle and fastened with a set screw that goes through a slot in the nylon spindle. The elasticity of the nylon material keeps the screw securely anchored, thereby preventing the knob from slipping either radially or horizontally while in use.

The knobs themselves are compression molded on an F. J. Stokes

modified press in standard molds. They incorporate an anodized-aluminum face insert.

The entire set—knob and spindles plus screws—is blister-packaged for rack merchandising at a retail price of 98¢, appreciably below the all-brass unit. According to Travco, the knob sets, in their modern design, have a strong appeal to housewives—who seem to be purchasing them in relatively large volume.

Hinges of ABS

What about the hinge field? When it comes to hinges, can plastics make contributions in terms of price or properties, or both? Judging by an ABS (acrylonitrile-butadiene-styrene) piano hinge recently introduced by Plastron Specialties Inc., Los Angeles, Calif., the answer is a resounding "Yes!" In this case, a switch to plastics brought improved corrosion resistance, self-lubricity, lighter weight, and reduced cost.

Originally, the hinge was designed for use on swimming pool weirs, where corrosion of brass, aluminum, and steel had represented a serious problem. Thousands of such weirs are now hinged in ABS. In addition, strong interest in this product has been expressed by the aircraft industry and dairy concerns, as well as a number of government agencies.

In a price comparison with other materials, the new hinge ranks far below brass, but higher than plated steels. Based on 1 ft. lengths at retail, actual prices are as follows:

Solid brass	$1.03
ABS	0.60
Cadmium-plated	0.50
Brass-plated	0.25
Nickel-plated	0.25

Since the last three listed are really not suitable in corrosive environments, they hardly enter the picture. A more representative cost comparison is this: while Industrial Specialties used to pay a wholesale price of $2.85 for a 6-ft. length of brass hinge, it can now charge a wholesale price of $1.62 for a 6-ft. length of ABS hinge—on the same quantity basis.

As to weight, which is always a factor, a 1-ft. length of ABS hinge weighs about ½ oz., compared to 4 oz. for brass.

The ABS hinge is extruded for Plastron Specialties by Ryko Products, Los Angeles, Calif. Industrial Specialties then cuts the extrusions to desired lengths, punches slots and holes, and inserts a 0.091-in. diameter molybdenum disulfide-filled nylon pin.

Judging by these three applications, plastics certainly seem to have successfully made their initial pitch for the lucrative hardware market. Note too that several firms are already engaged in developmental work on acetal door knobs, and we may expect their appearance on the market soon. While total volume for these applications is still small, the initial penetrations have been made . . . and a broadened base is foreseen by most observers in the plastics industry.

Credits: Locksets—nylon 6/6 by Du Pont; replacement knobs—nylon-6 for spindle by Spencer Chemical Co., urea by American Cyanamid Co.; hinges—ABS resin supplied by the Marbon Chemical Division of Borg-Warner Corp.—**End**

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New look in signs

(From pp. 90-92)

used extensively for vacuum-formed signs, background panels, and molded or formed letters because of its exceptional toughness, ease of forming, and excellent weathering properties. Its clarity and good optical properties are other important factors. New to the field is a duplex type butyrate laminate in which the two sheets of the laminate are of different color. Thermoforming the laminate and then sanding away the top layer is a quick and economical way to produce a two-color sign. (see MPI, Mar. 1961, p. 98).

For specialized types of displays, such as large three-dimensional units reproducing a product, package, human or animal figures, etc., reinforced plastics and rotationally molded vinyl plastisols are other materials frequently used.

A relative newcomer in outdoor signs is Mylar polyester film, now used as a printed overlay for trans-illuminated signs (see below).

For indoor signs and displays, where the problem of weathering resistance is no longer a factor, the choice of plastics is almost unlimited. Here may be found regular and impact styrene, cellulose acetate, cellulose butyrate and cellulose propionate, acrylic, vinyl, expandable styrene foam, and polyethylene. The final choice of material depends upon such factors as costs, method of fabrication, degree of complexity, number of units required, time available for tooling, and projected life expectancy of the unit. Often, the finished sign or display incorporates several types of plastics and two or more fabricating techniques.

Trans-illuminated billboards

One of the most significant advancements in design of plastics signs is the so-called trans-illuminated billboard, now being produced by several large sign manufacturers such as Advance Neon Sign Co., Los Angeles, and Industrial Electric Inc., New Orleans, La.

The essential difference between the new trans-illuminated boards and existing billboards is that the former, constructed of translucent plastic panels, are lighted from within. With the source of light behind the copy, there is no loss of lumen output, as with conventional boards illuminated by means of reflected light. Also, the light sources are shielded from dirt and weather exposure and cannot obstruct the view of the sign.

The copy itself, including any text or illustrations, is reproduced in full color directly on a thin Mylar polyester film by a photo screen process. The film has an adhesive on the back which permits it to be stripped onto the acrylic panels forming the sign, and also to be stripped off for replacement by new copy as required. Spare sets of face panels simplify the change from one copy or message to another; new panels are exchanged for the old right in the field on a single trip. Panels with outdated copy are returned to the sign shop so a new message can be applied.

Signs of this type have already made their appearance in several larger cities, and others are on the way. It is believed that these boards

will, within the next few years, replace many of the conventional flood-lighted boards now in use.

Trans-illuminated signs also show versatility in other directions. As used by Industrial Electric Inc., the film panels are printed one at a time, as are 24-sheet posters. Thus the film can be applied to backlighted translucent plastics faces; they can also be applied to opaque panels for use on cutouts, or they can be applied directly to painted bulletin faces. In this way, the sign maker has an economical means for displaying uniform copy on different sign media.

Recently Industrial Electric unveiled another new development made possible by modern plastic materials—a revolving spectacular sign. Comprised of 16 triangular trans-illuminated plastic sections, it makes it possible to combine three different signs in a single unit. The triangles automatically revolve in a cycle which permits 9 sec. of viewing time for each poster subject. Sixteen panels, each slightly more than 1½ ft. wide, make up the 25-ft. length of the sign.

Changeable letters fill many needs

Perhaps the best way to indicate the versatility of design that characterizes the use of plastics in signs and displays would be to look at what is happening in only one of the areas in this complex field—changeable signs.

Signs are meant to convey a message, and in most cases, this requires words and letters. Frequently, the message must be changed at intervals to feature new products, price changes, etc. The huge market for changeable signs has spurred a universal demand for individual plastic letters, in all shapes and sizes—and a number of companies are set up to supply them. Here are some of the newer items currently available:

Poster Products Inc., Chicago, Ill.: a changeable copy and display sign which consists of an extruded impact styrene background in choice of colors, onto which are mounted snap-in letters, figures, or words screened on acetate or other types of sheet stock. The background, which is available in various widths and continuous lengths, is extruded with parallel undercut

MANUFACTURE IN METROPOLITAN MIAMI

SEND FOR 16-SECTION DESCRIPTIVE BOOKLET OF THIS DYNAMIC AREA

This booklet will be mailed to you—in strictest confidence—if you write on your letterhead to the address listed below. Write: Richard J. Welsh, Director, Room 215.

DADE COUNTY DEVELOPMENT DEPARTMENT

345 NORTHEAST 2nd AVENUE • MIAMI 32, FLORIDA

An Agency of the Metropolitan Miami Government

famco-fiber glass fiber SURFACING MATS

Send for FREE sample

HERE'S a surfacing mat that is soft, drapable, uniform and wrinkle-free. We want you to see it. Famco-fiber surfacing mat is made of glass fiber filaments which are available with a variety of bonding resins. It's a whiter white, and it's easier to handle. Used in molding, it adds super-smoothness to your reinforced plastic product—and makes it more attractive.

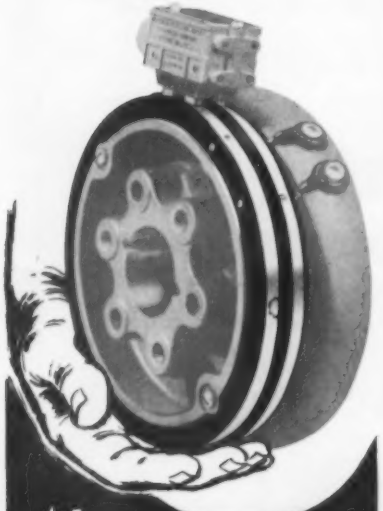
Famco surfacing mats are available in rolls 280 feet long and up to 72 inches wide in a full range of thicknesses. Call, write or wire for a sample. Famco, Inc., 6201 Strawberry Lane, Louisville, Kentucky.

famco, inc.

example...

FIBERITE

at work in electric clutches



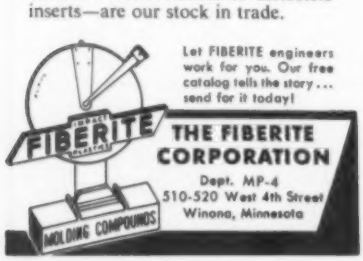
for Warner Electric Brake and Clutch Co., Beloit, Wis.

Warner Electric needed a plastic molded part to transmit power from brushes to a clutch magnet and turned the job over to Toledo Commutator Co., Owosso, Mich., and Great Lakes Plastics, Inc., Salem, Mich. These were some of the specifications—

- compatibility with bronze inserts from −20 to +200° F
- stability under rotational speeds to 3600 rpm
- dielectric resistance up to 2000 volts
- machinability
- high strength and durability
- minimum weight
- pleasing appearance
- competitive price

FIBERITE No. 4032 olive green (2 stage glass phenolic compound) did the job superlatively. On a production basis!

Plastic materials for special applications—from missiles to dielectric inserts—are our stock in trade.



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THE FIBERITE CORPORATION

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Winona, Minnesota

grooves which grip the flexible letters securely.

The Adaptaplex Co., Beaverton, Ore.; letters molded of butyrate, available in several sizes in either red or black. Ideal for merchandising use, they are weather-resistant, and have mounting pegs on the back which fit into openings in a vacuum-formed waffle-pattern background panel.

For large letters, *e.g.* thermoformed of acrylic or butyrate, there are other techniques. For example, in a typical store installation, fifty 24-in. and six 36-in. red acrylic letters were mounted against a white painted wood background. The fact that even the larger letters weighed only 5 lb. each made it possible to secure the letters to the building through clear acrylic angle brackets cemented to the letters. Stainless steel screws were used to minimize corrosion stains. For mounting to corrugated plastic backgrounds, very small holes may be drilled in the sides of the letters and stainless steel wire threaded through the openings, its ends twisted behind the panels.

Large injection-molded letters are also available for sign installations. Wagner Sign Service Inc., Chicago, for example, supplies them in several colors, in heights of 4, 6, 8, 10, and 17 inches. They are molded of a special weather-resistant formulation of Tenite butyrate. Also available from this company are Snug-Grip Plasti-Bars, extruded of transparent acrylic material, which may be cemented to any corrugated acrylic background material. Made in lengths from 3 to 10 ft., the bars are shaped in cross section to provide a secure fit for the tapered slots molded in back of the letters.

Still another approach to the changeable letter type of sign is a modular unit introduced by Merritt Products, Azusa, Calif. This vacuum formed sign is comprised of 27-in. (or smaller) panels formed of 0.080-in. clear butyrate sheet stock, masked and sprayed on the rear side. Finished signs are produced by sliding the separate letter panels into channels of 0.025-in. aluminum, which may be mounted to various surfaces. The sheets are extruded of Tenite butyrate by Jet Specialties Co., Los Angeles, Calif.

On large-area units, where additional structural requirements are imposed, one recent approach utilizes modular extruded or formed channels (*e.g.* right-angled corrugations) of the acrylic or butyrate. Joined side by side, such channels make possible construction of continuous two-dimensional luminous areas up to 50 ft. high and of unlimited width. Letters may be wired to the face of the combined channels, painted on the **(To page 171)**

Acrylic sheet—comparison of cast and extruded types

This comparison of cast and extruded acrylic sheet—presented here for the guidance both of the sign maker and of the designer—is based on information supplied by George L. Dwyre of Southern Plastics Co., Columbia, S. C., a leading supplier of extruded sheet.

Optical clarity: cast sheet is superior in this property, although in most applications the difference in clarity between the two types is too small to warrant concern.

Painting: the cast variety offers better resistance to pigments and solvents.

Heating characteristics: extruded sheet has a lower critical temperature than does cast sheet, and also heats faster. For 4- by 6-ft. sheet, extruded will reach critical (forming) temperature of 310° F. in little over a minute; the cast sheet will take 3 to 3½ min. to reach its forming temperature, 340 to 370° F.

The extruded sheet, however, must be framed or supported at all edges because of its inherent shrinkage characteristics; this is not necessary with cast sheet.

Sizes and gages available: size is probably the most important advantage of extruded sheet—it is available in a wide variety of lengths and widths. It is possible for sign makers to order "net blanks"—sheets cut to exact size to eliminate postforming trimming and waste. This permits consideration of designs which would otherwise entail sizable cutoff losses if cast sheet were used.

Thickness tolerances on extruded sheet are somewhat closer than on cast. This permits closer conformity to metal framing and, in some instances, use of a somewhat lighter, less costly sheet.

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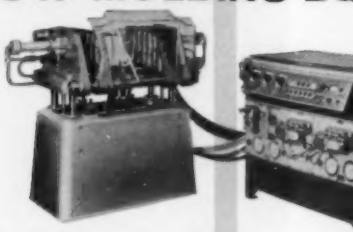
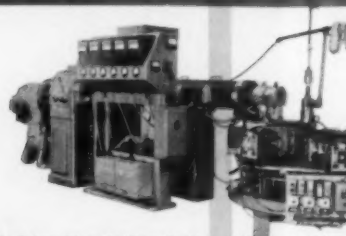
Management and Personnel at a recent sales meeting

Rainville Research and Development Laboratory

BLOW MOLDING EQ



1. ½ Gallon Blow-O-Matic Rising Mold Type Machine



5. Rainville Rotary Blow Molding Machine—6 Station—1000 p
with TRS 80—3¼" Luigi Bandera Extruder with double zone

EXTRUSION EQUIPM

9. TR 30 (1⅛") Bandera Extruder

10. TR 120 (4

14. Vern Emery Saw—Model 4 cuts
up to 4" pipe

15. Vern Emer
up to 9" pipe

PRINTING & MARKI

19. Kammann K 10 Manual Silk
Screening Machine for round objects
such as blown bottles

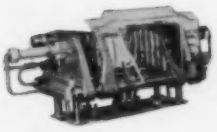
20. Kammann
Bottle Silk Sc

FOREMOST SCRAP

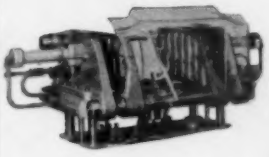
24. 3C-2 Hi-Shear Grinder—
10" x 12" Throat; 3 or 5 hp motor

25. HD-1 Hea
8½" x 10" T

QUIPMENT



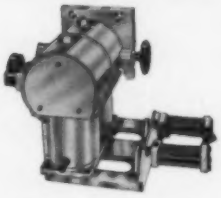
2. 2½ Gallon Blow-O-Matic Table



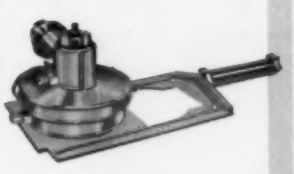
3. 5 Gallon Blow-O-Matic Table

4. 1½" Parison Head—5 Station

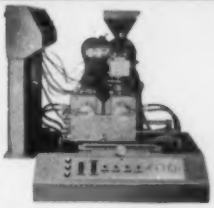
per hour dry cycles,
extrusion head.



5. 2" Double Head—Adjustable Parison Wall

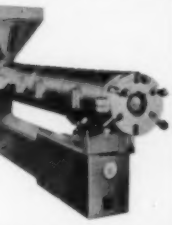


7. 15" Single Crosshead



8. S.C.A.E. (made in Italy) One Size —One Quart—1200 Dry Cycles— Air Operated

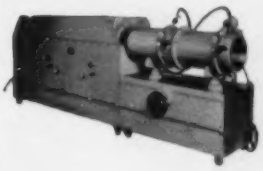
MENT



¾") Bandera Extruder

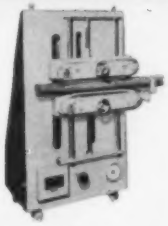
11. Rainville 2½" Extruder—20 to 1 L/D Ratio—42" Centerline— Standard Arrangement

12. Rainville 2½" Extruder—20 to 1 L/D Ratio—Base Arrangement for Blow Molding

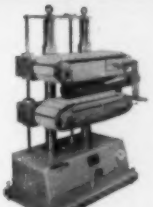


13. Bandera Vacuum Pipe Sizer

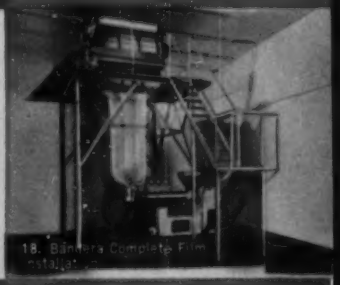
ry Saw—Model 9 cuts



16. Speedex Model 0/3 Puller

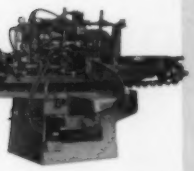


17. Speedex Model 0/5 Tractor-Type Haul Off (up to 5" capacity)



18. Bandera Complete Film

NG EQUIPMENT



K 5 B Fully Automatic
creening Machine

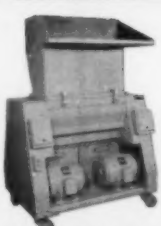
21. Kammann K 11 Automatic Sidewall Printer

22. Rainmark Model 25 High Capacity Rotary Hot Stamping Machine

23. Rainmark Model 30 Reciprocating Table Hot Stamping Machine

GRINDERS

vy Duty Grinder—
Throat; 3 or 5 hp motor



26. HD-4 Heavy Duty Grinder—10" x 28" Throat; 7½, 10 or 15 hp motor

27. HD-2 Grinder Equipped for Pipe Grinding

28. Heavy Duty Model 6B Lump Cutter

Where to phone or write

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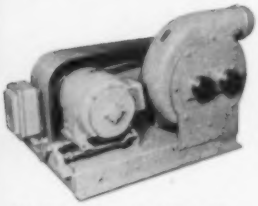
Pioneer 6-7135
Henry Thielfoldt
John Stracey
Stanley Currans

The Rainville Company, Inc.

839 Stewart Ave., Garden City, L. I., New York

FOREMOST AUTOMATIC SCRAP HAN



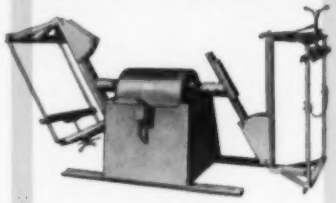
29. Cutter Blower for automatic removal of sheet edge trim

30. Under-the-Press Grinder-Blender-Loader. Scrap inlet height as low as 16" from ground

31. 3C-2 Roll-Feed G grinding scrap in rol

LOADING AND MIXING

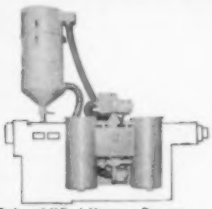
35. Foremost 1" Automatic Hopper Loader including Level Switches, Drum Clamp, Solenoid Valve, etc.



36. Rainco Drum Tumbler with Floor-Level Loading

37. Rainco Flake L

DRYING AND DEHUMIDIFYING

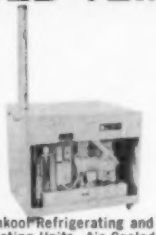


41. Dehumidified Hopper Dryers. A complete line of efficient dryers from 50 to 1000 lbs. per hour

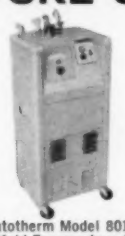
42. Una–Dyn Hopper Dryer complete with efficient air distribution hopper and dust-free Rainco Vacuum Loader

43. Una Dyn Model Loading Combinatio Loader

MOLD TEMPERATURE CONTROL



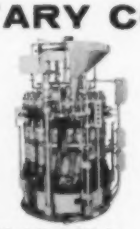
47. Rainkool Refrigerating and Recirculating Units–Air Cooled and Water Cooled



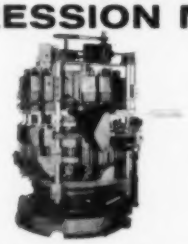
48. Autotherm Model 801 Single Zone Mold Temperature Control Unit–50 degrees F to 230 degrees F

49. Autotherm Mod Mold Temperature 50 degrees F to 23

ROTARY COMPRESSION MOLDING



53. Cropp 20 station–3½ to 10 tons per station. Fully automatic continuous compression molding with powder or preforms.

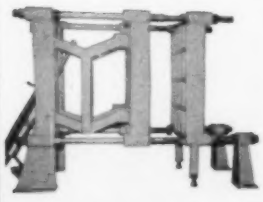


54. Cropp Hydraulic 20 station–8 tons per station

55. Cropp Rotary Tr

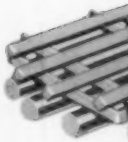
EXPANDABLE POLYSTYRENE

59. Slocomb Expandable Polystyrene Steam Expander–Model 2 shown. Available in 3 sizes



60. Rainco Expandable Styrene Molder

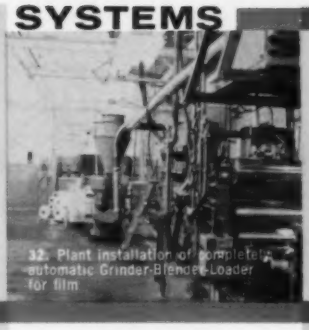
MISCE



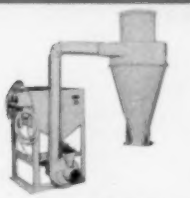
61. Rainville Grate ferrous metal conta

NDLING SYSTEMS

Grinder for
ll form



32. Plant installation of complete fully automatic Grinder-Blender-Loader for film



33. Adapter Unit and Impeller Loader to convert any standard grinder to an automatic Grinder-Blender-Loader

34. Model 3XX Grinder with variable speed feed roll for light gauge sheet

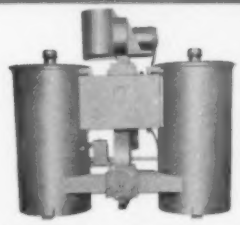
Loader

38. Rainco Standard Vacuum Loader —1200 pounds per hour capacity

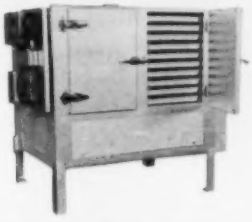
39. Rainco High Capacity Vacuum Loader—1800 pounds per hour capacity

40. Rainco Loader with Dust Tight Mounting

el AO-2—Floor
ion Dryer-Hopper



44. Model AM-15 Molecular Sieve Dehumidifier



45. Foremost 20—Tray Oven

46. Foremost 40—Tray Oven

del 802 Dual Zone
Control Unit—
30 degrees F

50. Autotherm Model 805 Single Zone Atmospheric Pressure Unit—4500 Watt Control Unit—50 degrees F to 210 degrees F

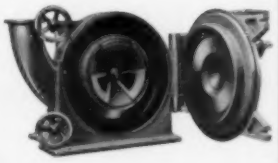
51. Autotherm Model 807 Dual Zone Hot Oil Mold Temperature Control Unit—100 degrees F to 500 degrees F

52. Autotherm Model 810 Cooling Only Unit for Vacuum Forming or Extrusion Screw Cooling for Use on Water Only—50 degrees F to 210 degrees F

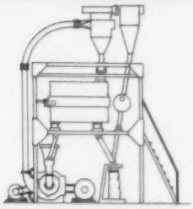
FINE GRINDING EQUIPMENT

ransfer Press

58. Pallmann PP 6 for "powdered" thermoplastics down to 100 mesh without refrigerant



57. Pallmann RF 8



58. Pallmann complete plant installation with automatic screening

LLANEOUS

e Magnets for
tamination

62. Mayhew Oil Reconditioner—Model MT-1

63. Model 30 Doyle Vacuum Cleaner

64. Rainville Mold Release

1 to 4 cases	$12.00 per case
5 to 9 cases	11.50 per case
10 to 24 cases	11.00 per case
25 to 49 cases	10.50 per case
50 or over	10.00 per case

first surface, or handled in other ways. Also, channels extruded of different color materials may be fabricated and cemented together so that the lettering is flush with the surface of the channels.

One of the largest plastic signs using this extruded corrugated section as a background is a 25- by 40-ft. double-faced unit (photo, p. 91) designed by Jos. Schlitz Brewing Co. and made by Everbrite Electric Signs Inc., Milwaukee.

A variety of materials

Other new techniques and new materials are also beginning to make an appearance in the field.

The growing complexity of modern merchandising displays frequently necessitates use of a combination of techniques and materials. For example, take a display mounting for Jacques Kreisler ladies' watch bands. Produced by Thomas A. Schutz Co. Inc., Chicago, it incorporates a blow-molded polyethylene feminine head, in combination with a base and pedestal molded of expandable styrene foam. The display frame mounted beside the head, on which the watch bands are exhibited, is injection molded of styrene, with a vacuum-formed impact styrene background. This was given a textured surface by forming it against a piece of cloth placed in the mold.

No one can observe today's tremendous variety of signs and displays without being impressed by the fact that plastics have literally revolutionized this field and given it important new dimensions in design, lighting, and overall impact. And no one can doubt that plastics will continue to dominate in signs and displays—while steadily adding to its share of the market—as new techniques and materials evolve and as designers and advertisers become familiar with these advantages.

Credits: In addition to those mentioned in the article, MODERN PLASTICS gratefully acknowledges the cooperation of the following companies and organizations in supplying information and/or photographs: Campco Div., Chicago Molded Products Corp., Chicago, Ill.; Eastman Chemical Products Inc., Kingsport, Tenn.; National Electric Sign Assn., Chicago; Neon Products Inc., Lima, Ohio; Plasti-Line Inc., Knoxville, Tenn.; Rohm & Haas Co., Philadelphia, Pa.; and Tel-A-Sign Inc., Chicago.—End

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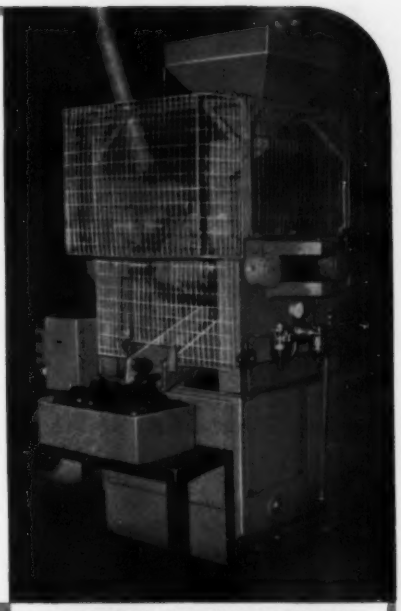

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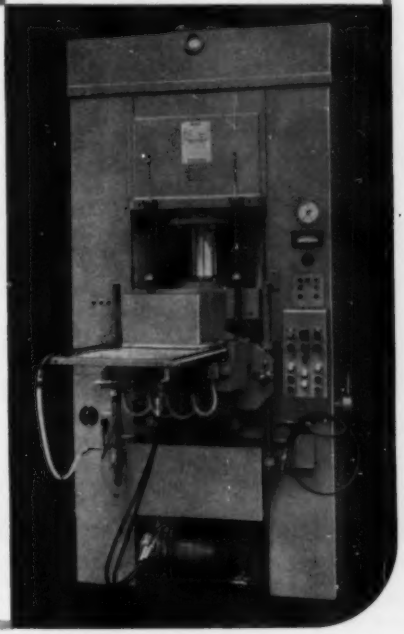


Cure cover

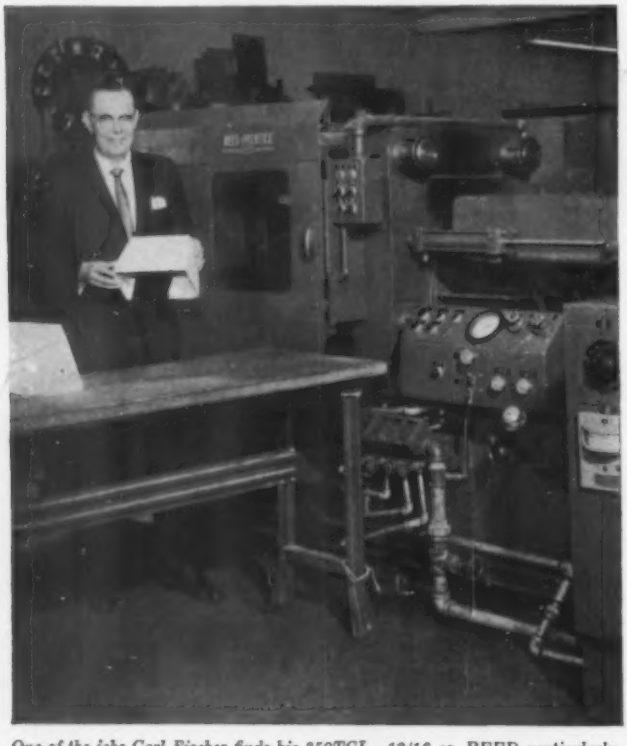
(From page 93)

use of 4-mil white opaque PE film in highway construction points up these advantages in more detail.

- According to the report, the film's flexibility permits it to maintain good contact with the surface of the pavement, keeping the surface uniformly moist throughout the curing period. Paper, in contrast, because of its stiffness, allows more air spaces to be formed between it and the concrete. In these air spaces, the moisture vapor alternately condenses on the underside of the paper at night and on the pavement during the day.
- Light weight and imperviousness to water makes the film easier to handle and reuse. Two men are able to handle a 200-ft. roll of the film in 14-ft. widths. Unlike other materials, the moisture-resistant PE does not gain any weight after a rainfall nor is there any likelihood of rain causing it to crack (as might happen with paper) or mildew (as with burlap). The New York State report also points out that the 4-mil PE was successfully used an average of six times (other sources, however, report as many as 20 reuses of the film).
- Taking advantage of the film's availability in lengths up to 1500 ft. and in widths up to 24 ft., highway engineers were able to use sheets wider than the pavement slabs, eliminating the need for "runner strips" or overlapping sheets.
- The opacity and white color of the film also help reflect sunlight and prevent any sharp rises in temperature under the curing cover that might tend to affect the quality of the concrete.
- And a final added bonus: evaluation tests indicated that cores taken from concrete cured with PE film had a slightly greater average compressive strength than cores taken from concrete cured with waterproof paper.

With reports such as this, it is small wonder that PE film has already shown up in other aspects of highway and airport runway construction. As a moisture barrier under such concrete slab, 1-mil-thick clear film is already in wide use. More recently, PE film has been used to cover sawed joints in rigid concrete pavements. This is a critical aspect of the curing operation, since pavement failure frequently begins at the joint. To do the job, a 2½-in. wide, 0.0045-mil PE tape was developed (by Presstite Div., American-Marietta Co., St. Louis, Mo.), with two ribbons of adhesive mastic extruded onto one side. The tape, with a removable paper backing, is supplied in rolls. It is applied to the concrete, with the adhesive on either side of the joint (which is sawed to allow for expansion and contraction of the concrete), completely covering it. This prevents not only loss of moisture but also the infiltration of foreign matter into the joint.

With applications such as these, it is becoming obvious that those optimists who have been predicting that the relatively obscure heavy-duty uses for industrial films will soon be increasing at a faster rate of growth than packaging uses for films (see MPI, Dec. 1960, p. 75) may see their hopes take shape sooner than they expected.—**End**



One of the jobs Carl Fischer finds his 350TCL—12/16-oz. REED particularly well suited to is a 14½-oz. high impact styrene shot for the outer case of a Royal Shoe-Master electric buffer. For full details on this or any REED model, call your nearest Reed-Prentice Sales Engineer.

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"I like everything about my new 350TCL—12/16-oz. REED. The quick action of the toggle mechanism, positive lock-up and good cubic inch displacement of material with its fast plunger action make this REED tops with me. I never thought anyone could build so much into one machine."

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New polymer

(*From pp. 94-95*)

resistance to abrasion, chemicals, and stress cracking, make it a logical choice.

In applications where the use of plasticizers might result in extraction, migration, or evaporation of the plasticizer, the flexible grade of the blend (870) can be used to good advantage. This is true in the case of hollow containers, made either from sheet or blow molded, where extraction of the plasticizer components can contaminate contents.

The absence of plasticizers in this material make it highly useful for electrical insulation applications. For example, the electrical properties of Hostalit Z 870/70 are comparable to those of normal unplasticized PVC, and reportedly show a higher current flow resistance than normal plasticized PVC.

The properties of this blend are listed on page 95. Here it is important to note the major characteristics of the Hostalit Z grades. As compared to rigid PVC, Hostalit Z 820 and 720 have greater notch impact strength, and are easier to process. In addition, they can be more easily stabilized against light and weather. But since the other physical properties of Hostalit Z are practically uninfluenced by the blend of two high polymers, the Hoechst material can be said to be comparable to Rigid PVC.

The softest grade, Hostalit Z 870, corresponds in softness and flexibility to a plasticized vinyl compound with a dioctyl phthalate content of approximately 20 percent. Using special plasticizers, it is possible to produce a soft PVC compound with dimensional stability for either low- or high-temperature service, but one result is usually obtained at the expense of the other. Hostalit Z is reported to offer dimensional stability at both low and high temperatures, chemical and solvent resistance, and good electrical properties. Properties of the 840 grade fall between the two above mentioned grades.

Processing methods

The same methods used to process PVC can also be used for Hostalit Z, including processing conditions and equipment. Often, the new blend is easier to process because of its easier flow characteristics. Processing temperatures range from 320 to 375° F., depending upon the grade used, the process, and the equipment. The harder grades usually require somewhat higher temperatures than the soft types. Because of the easier flow of this polymer blend, there is less wear on the processing equipment. However, the basic design rules for PVC processing should be followed.

The manufacturer recommends that this material be compounded and pelletized before it is run. This is necessary for two reasons: 1) Hostalit Z is supplied as a mechanical mixture of two powdered resins, and compounding and pelletizing will serve to homogenize the material further, thus assuring a uniform composition; 2) pellets feed and process more efficiently than powder in injection machines, extruders, and other hopper-feed equipment.

In the United States, Hostalit Z is available from Hostachem Corp., Mountainside, N. J. The blend sells for 38¢/lb. in 820 and 720 grades, 45½¢/lb. in 840 grade, and 52¢/lb. in the 870 grade. For carload quantities, these prices are 2¢/lb. less, while custom compounding adds about 4 or 5¢/lb. to the resin price.—**End**

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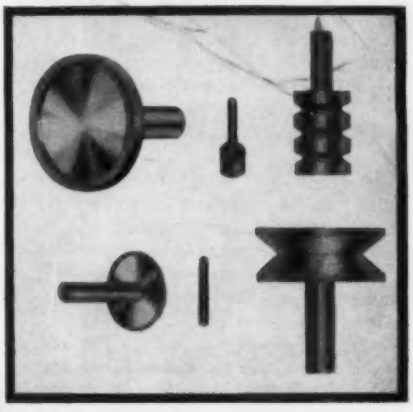

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TENITE DEVELOPMENT LABORATORY DOINGS AND FINDINGS

WITH A LITTLE BIT OF LUCK

Remember the story of the Chinese boy who "discovered" roast pork the day his house caught fire and his pet pig failed to escape? A legend, probably — but logical. Chance has undoubtedly played a major role in many a discovery. Five or six years ago, for instance, some plastics engineers were watching experimental polyethylene paper-coating trials at a plant in upstate New York. Their eyes widened when the paper accidentally broke and the polyethylene coating continued to emerge from the chill-rolls . . . as highly lustrous film! Like the Chinese lad, the engineers got the implication. Today, chill-roll extrusion is a well-established technique for fabricating sparkling, highly transparent polyethylene film.

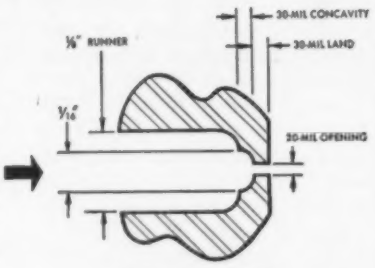
By investing in high-speed, chill-roll equipment for its own test purposes, Eastman has been able to develop excellent film-grade Tenite Polyethylene formulations for specific end uses such as bread overwrap.

SMALL GATE—BIG HELP

Every molder loves a small gate; it makes possible a part that comes quickly free of the mold and requires no trimming. Unfortunately, it may also impede flow, thus preventing the cavity from filling completely or slowing the molding cycle.

Through their test work with Tenite Acetate, Butyrate, and Propionate, Eastman's engineers have hit upon a new design for a 20- to 30-mil gate that often works where the conventional pinhole gate fails. Even where the pinhole gate has been found satisfactory, indications are that the new design can speed the molding cycle.

Here is the new design:



MODIFIED PINHOLE GATE

It differs from the conventional pinhole gate in just one small, but very important, way. The runner (or sprue, if runners are not used) stops just short of the gate's land. A machined cavity half the size of the runner then extends it to the land.

What makes the design work so well, we think, is the flow pattern that develops as the hot plastic enters the gate. The wavefront traveling down the runner breaks across the small concavity and forms streamlines that help the plastic shoot smoothly through the gate and into the mold.

A COOL 6 BILLION

Six billion pounds of frozen food, we're talking about. That's the astronomical figure projected for 1970. Naturally, the packaging for such a harvest takes on prime importance. Eastman's popular entry in this pouch-packaging field: Tenite Polyethylene 161M Natural. This new polyethylene formulation, with a density of 0.923 and a melt index of 0.7, has been exceptionally well-received for making film used to package foods that are IQF—individually quick frozen. The significant word is individually. With each little pea, bean, or carrot cube frozen separately from its fellows, vegetables remain loose rather than becoming a solid block, and can be poured from the package in just the quantity needed for immediate use.

A preliminary survey (we asked our wives) reveals that the housewife not only prefers IQF foods because of their loose form, but also finds the polyethylene pouch much easier to open than boxes.

For more information on Tenite Polyethylene 161M, contact your nearest Tenite representative or write to Eastman Chemical Products, Inc., Plastics Division, Kingsport, Tennessee.

TENITE®

plastics by Eastman

Polycarbonate

(From page 87)

the two-way blow modules. All are engineered for mounting in several types of metal frames, making it possible to adapt the installation to any ceiling tile pattern or suspension system. This design approach permits close control of such factors as direction of air flow, noise level, etc., for an efficient installation. Modules snap quickly out of the supporting frames to facilitate easy cleaning.

Depending upon how the individual diffusers are oriented in the frames, it is possible to form an air distribution pattern in one, two, three, or even four directions as required. Each molded unit can be conveniently rotated or replaced in the frame to project ventilating air in another direction if future floor layout makes it necessary. In this way, when building partitions or fixtures are relocated, no costly air distribution alterations are needed.

Polycarbonate material was specified for the new Carnes diffusers after extensive testing of various possible plastics. Among the basic reasons for the choice of this material were its excellent self-extinguishing characteristics upon exposure to flame (an important factor because rapid air movement through the diffusers could tend to spread flame if a self-extinguishing material were not used). The polycarbonate material also showed better color stability and resistance to distortion under temperature extremes than a number of other materials that were tested.

At present, the diffusers are being produced from two molds which are run on 8-oz. injection machines—a single-cavity mold, which turns out the two-way corner type unit, and a two-cavity mold, which makes a one-way and a two-way diffuser on each press cycle. The latter parts are produced with a straight draw, while the single cavity mold incorporates a hydraulically operated side pull in the corner section to provide the desired two-way treatment of the vanes.

Credits: Diffusers injection molded of General Electric's Lexan polycarbonate resin by Flambeau Plastics Corp., Baraboo, Wis. Molds by A-1 Tool & Die Co. Inc., Stone Park, Ill.—**End**

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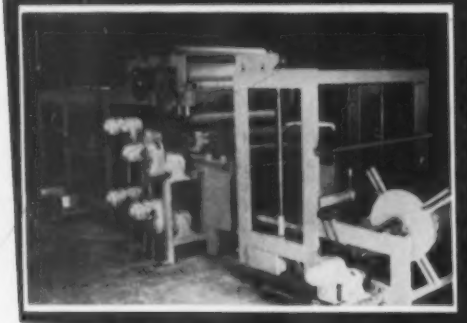

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Fuel regulator

(*From page 99*)

regulators constructed of metal or glass and metal. The three major components of the regulator—top piece or cap, bottom or bowl, and the insert to which working parts are mounted—are injection molded to tolerances of ±0.002 inch. Initial production was from a three-cavity family mold, but separate multi-cavity molds are to be used.

Why nylon was chosen

Nylon was selected for this application because it combined several desirable features. In addition to its high mechanical strength, the resin is unaffected by gasoline and will successfully withstand high engine compartment temperatures without distorting or changing molecular structure.

No drilling, threading, or other mechanical finishing operations are required on the plastic parts. However, the largest component (the bowl) is dip-dyed red. This is done for merchandising purposes, and to help insure that the device is installed in proper position.

In addition to low cost, another advantage of the Miser Mite's plastic construction is its light weight, which makes it possible to eliminate the need for metal clamps and other fittings required to hold heavier metal units in place and overcome engine vibration.

In translating this device from blueprint to actual production, the molder developed the molds and was also responsible for certain design changes that facilitated molding and reduced costs.

For example, original specifications called for a threaded bowl and cover construction which would have necessitated the molding of mating threads on the two housing components. Here the molder, Artag Plastics, recommended a much simpler, but no less effective, bayonet-type lock to join the bowl of the regulator to the cap. With this arrangement, a short twist of the lock produces a permanent, unbreakable seal.

Credits: Nylon components for Miser Mite produced by Artag Plastics Corp., Chicago, Ill., using Du Pont Zytel No. 2281. Initial production was on a Reed-Prentice 12-oz. injection machine.—**End**

RP pontoons

(From pp. 100-101)

An additional advantage claimed for the pontoons is that they can be nested for low-cost delivery; the ¾-in. plywood top is put in place later when the entire float is ready to be assembled.

Pontoons made by the preform molding process are now in use in a new small-boat anchorage in Long Beach, Calif. This is believed to be the largest municipal marina in existence. Its miles of floating walkways and finger piers are supported by 5000 of the preform pontoons. The pontoons have also been used in Coast Guard installations on the West Coast and are being used in East Coast marinas.

These pontoons, four-sided boxes with slightly slanted sides, come in four sizes: 8 ft. long in two widths —3 and 4 ft.; 6 ft. long in two widths—3 and 4 feet. All are 16 in. deep. Weights range from 87 to 142 lb., buoyancies from 1360 to 2520 pounds.

The pontoons are made of an isophthalic polyester resin especially compounded for the job by Minnesota Mining & Manufacturing Co. and are molded by Zenith Plastics Co., Gardena, Calif., a 3M subsidiary. The reinforced plastics compound is sprayed onto a form, partially cured, and then molded under 400 to 600 p.s.i. at 275° F.

Two half shapes are molded on the same matching molds and joined together with a high-strength 3M epoxy cement. Pontoons are tank-tested under pressure to check for complete sealing.

The pontoons have a wall thickness of only 0.178 in. at the area of greatest stress, but are strengthened by a molded-in inverted rib design. This makes for lightweight pontoons which can be attached underneath a float on dry land, and the whole structure then hoisted by derrick into the water. The pontoons are provided with a pump-out fitting which permits replacement pontoons to be flooded, moved into place and then pumped out for buoyancy.

Credits: Used in making the Pacific Float Co. pontoons are: continuous strand roving by Owens-Corning Fiberglas; polyester resins by American Cyanamid; and a spray gun by Seal-Zit Co. of America.—**End**

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POLYPROPYLENE
REGULAR...SEILON PRO

ABS
REGULAR...SEILON S-3

ABS-HT
HIGH TEMPERATURE...SEILON S-3 HT

ABS-FR
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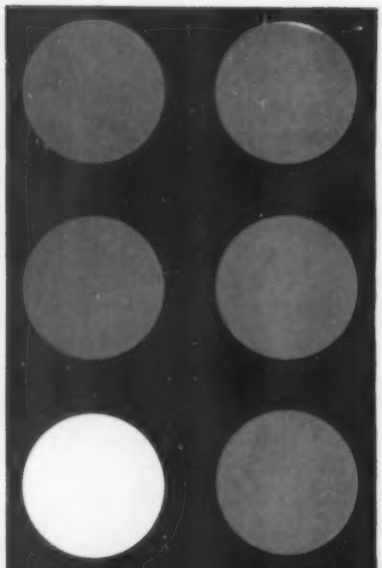

DIFFERENT?

Let's assume that these circles represent your product and five competitive products. There may be no significant difference in design, concept, operation, or construction, yet, one catches the eye more than the others. We've represented this stand-out product by the white circle —it's not really different, it just looks different.

If your product had this ability to capture more attention than competitive products, wouldn't your sales benefit? Of course. And, you can build this type of difference right into your product. Here's how:

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Embedment equipment

(*From pp. 105-112*)

tanks, vacuum pumps and casting equipment, flow meters, and other special auxiliary equipment.

Although there are many different proportioning, mixing, and dispensing systems available, only three different systems will be described here. The basic principles are used in these three units, and minor variations are used in many other systems.

The Automatic Process Control system

This system (4) is shown schematically in Fig. 4, p. 108. Low-pressure air is admitted to both the hardener (A) and compound (B) storage and mixing tanks. The air pressure forces both the hardener and the compound through check valves (C,D) into all parts of the hardener and compound systems respectively. On the hardener side this includes the line (E), leading to the mixing and dispensing head, the hardener cylinder (F), and the hardener reservoir (G). Only enough hardener is allowed into the reservoir to provide a seal on the hardener cylinder. Then the priming valve (H) is closed.

On the resin side of the system, resin is forced into a separate line (J) leading to the dispensing head and into the right hand side of the bellows chamber (K) above the first check valve (D). The left-hand side of the bellows chamber (L), which is sealed from the right-hand side by a flexible diaphragm (M), is filled with an hydraulic oil. Enough oil is added to the oil reservoir (N) to provide a seal on the cylinder on the compound side (D), and the priming valve (P) on this side of the system is closed. The two cylinders are then positioned laterally with respect to each other on the two bars, one of which is fixed (R) while the other is free to pivot on one end (S). From the mechanics of the system it will be observed that the lateral distance between the two cylinders (F,O) on the bars will determine the ratio of the hardener and compound which will be delivered to the mixing and dispensing head (T). To deliver a shot of resin, high-pressure air is applied to the hardener and oil reservoirs. This forces the pistons in the cylinders to move upwards, forcing the resin and compound to move through the mixing and dispensing head. Simultaneously, with the application of air to the reservoirs, a valve also admits high-pressure air to the dispensing head, to open the head valve (V), and to the air motor (X) which speeds up the mixer impeller.

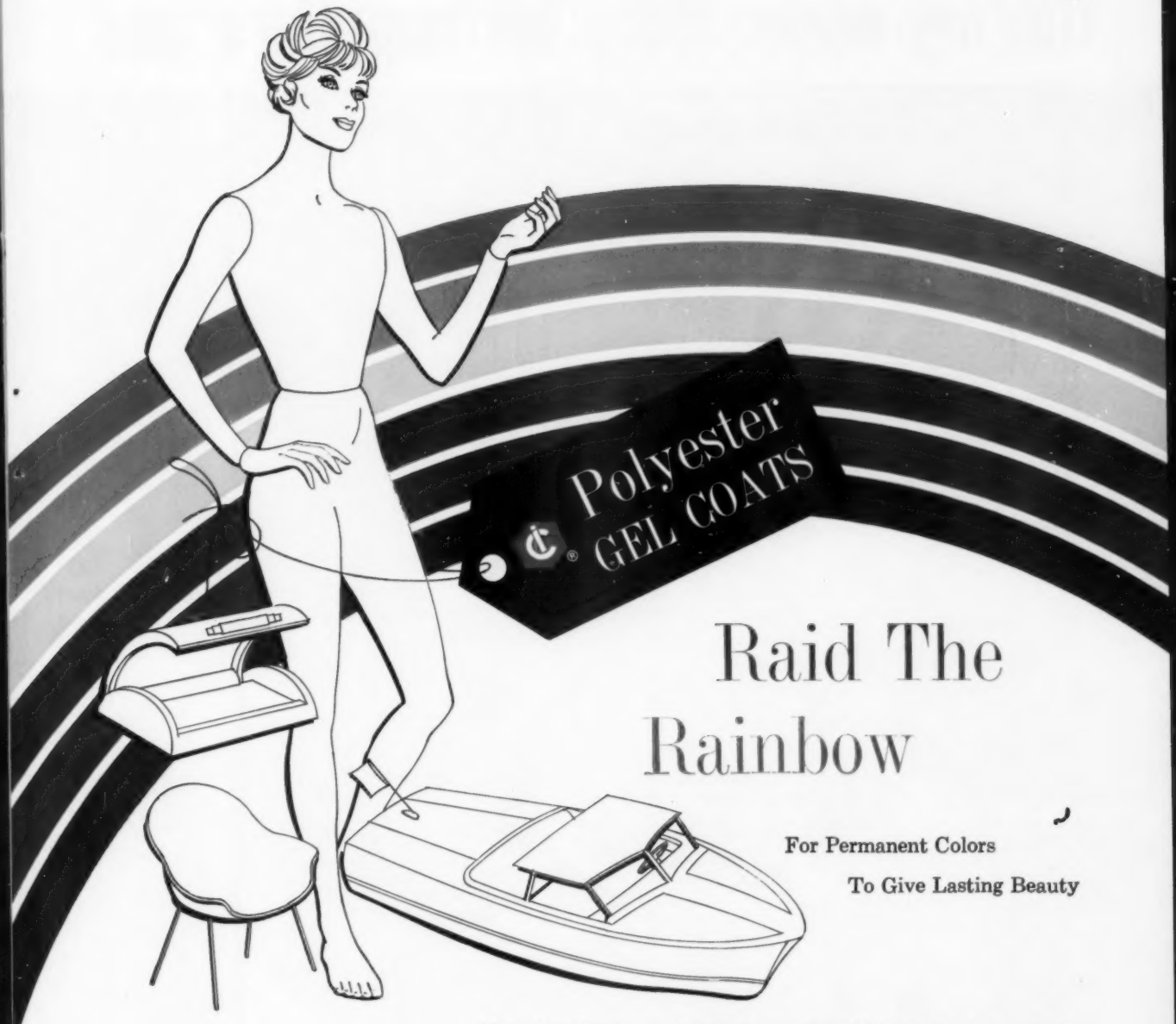
On the compound side of the system, the flexible bladder chamber is used to isolate the compound, which may contain abrasive fillers, from the moving parts in the compound delivery cylinder and a separate oil system is used to drive the piston. On the hardener side, the hardener usually has no filler in it and is, therefore, also used as an hydraulic fluid in the hardener cylinder. Because the volume of material delivered per shot is fixed by the travel of the piston in the cylinder (positive volume displacement principle), the shot volume is independent of the resin's viscosity. The amount delivered per shot can be varied by adjusting the travel of the movable bar (S). Note also that the discharge will be an intermittent pulsating flow.

The Hull-Standard system

Instead of using the positive-displacement cylinders, this machine (5) uses pressurized storage tanks, feeding at regulated pressures through micrometer metering valves. (See Fig. 5, p. 110). Thus, catalyzed resin can be delivered as a continuous flow if desired, rather than being limited to a definite preset size. When operated intermittently the shot size can be varied as desired and can be actuated by using a foot pedal control. Since flow is continuous, there is no cylinder recharge time required as in the positive-displacement cylinder system. The ratio of resin to hardener or curing agent is preset by adjusting the micrometer metering valves and regulating pressure.

The Hardman system

Hardman Series 500 machines (6) differ from the above systems in that a gear pump is used for metering. The gear-pump system has a high output rate, and can handle high viscosity resins, (up to 100,000 centipoise) **(To page 182)**



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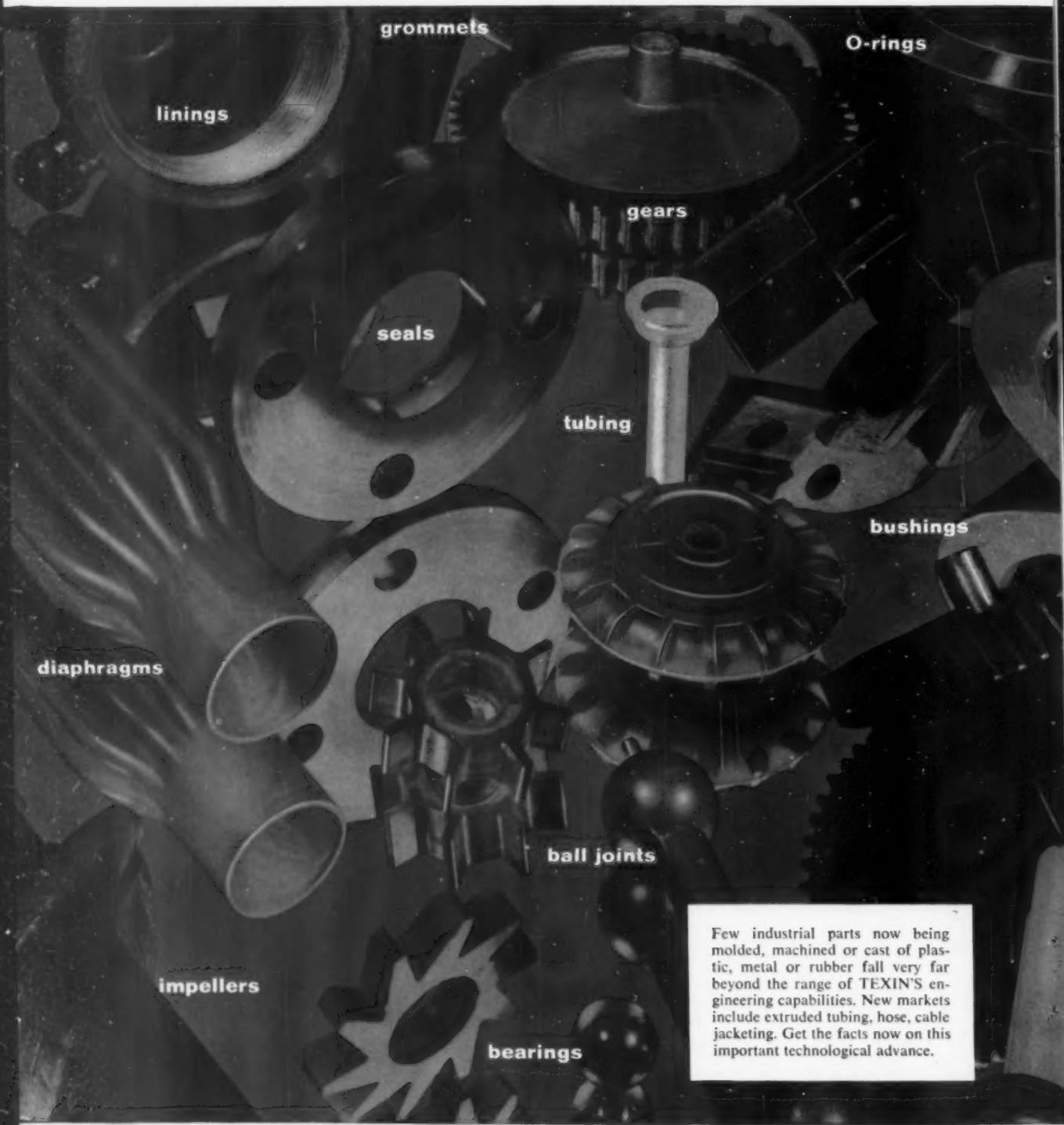

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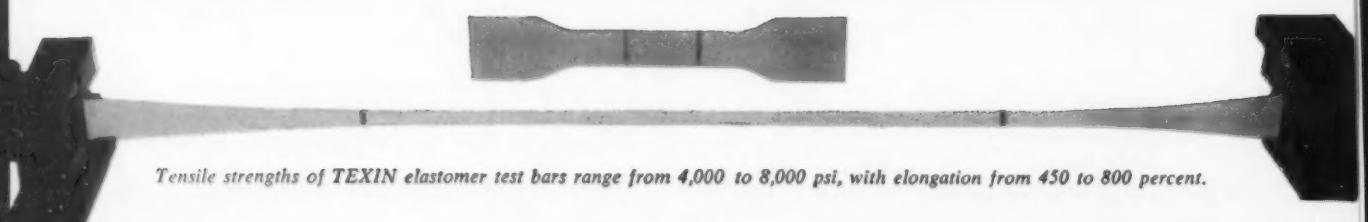

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The markets for urethane elastomer items are already well developed and waiting to hook into your production line. For full details and technical assistance, write immediately to Mobay Chemical Company, Code MP-4, Pittsburgh 5, Pa.

Typical minimum physical properties of two grades of TEXIN

Type	Specific Gravity	Bulk Factor	Hardness		Tensile Strength	Elongation at break	Tensile Modulus psi			Elongation Set	Tear Strength
			Shore A	Shore D			100%	200%	300%		
192 A Molding Grade	1.25	2.7	92–94	44–45	4400 psi	600%	1150	1550	2050	45%	300 lbs.
280 A Extrusion Grade	1.25	2.7	80	—	5500 psi	600%	650	900	1500	30%	—

Send for your copy of Texin Topics, an illustrated bulletin describing the latest application developments in the urethane elastomer field.

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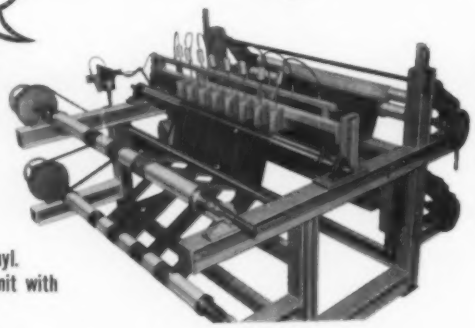

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without the dwell time required for reloading in positive-displacement systems. This gear-pump system needs no auxiliary valves. Purging is by uncatalyzed resin instead of solvent.

The Hardman system dispenses mixed materials intermittently. Each time the switch is energized, one shot of resin and a proportioned shot of curing agent are pumped into the mixing chamber. Then the pumps automatically recharge. If the operating button is held on, the shots are repeated 72 times a minute. Controls are available to give two or more shots per cycle to allow automatic filling of large molds. The volume of each shot is also adjustable.

The Hardman Series 500 machine is shown in Fig. 6, p. 112. The gear pumps may wear somewhat when used to pump resin loaded with abrasive fillers, such as silica or alumina (6). However, the rate of wear has been found to be linear, allowing an accurate prediction of recalibration schedules and replacements.

Selecting a machine, one can not generalize that any one system is better than another. The merits of a system are relative to specific requirements. The potential user should study all the available systems before making a choice. The systems described are listed only to demonstrate different operating mechanisms which are used for automatic metering, mixing, etc.

In selecting equipment there are questions which each potential user should ask himself about the equipment being considered. Some of the more important questions are:

1. Are the materials of construction compatible with my resin filler in contact with the materials and catalyst system? This would include both metal and plastic parts. If there is any doubt, a test run should be arranged.

2. Is the machine designed to avoid resin freeze-ups?

3. Can the system be purged rapidly and conveniently in case of trouble?

4. Does the machine have resin filters to prevent dirt from clogging valves, orifices, etc.?

5. Can the machine resist wear under the action of abrasive filler?

6. Will variations in compound viscosity cause variations in pro-

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EQUIPMENT • SUPPLIES • SERVICES

CRUSHERS. 6-page illustrated folder describes line of horizontal saw tooth and vertical cone crushers. Complete description, specification charts, other data. The Young Machinery Co., Inc. (101-D)

INJECTION MOLDING. Illustrated bulletin describes automatic injection molding machine including data on screw-plasticizing and plunger-injection. General description, technical data, capacity data, other information. Netstal Machine Factory & Foundry, Ltd. (102-D)

CORRUGATED BOARD TOTE BOXES. 8-page illustrated folder describes features, uses of line of chemically hardened corrugated board tote boxes in assorted shapes and sizes. Convoy, Inc. (103-D)

EXTRUDING EQUIPMENT. Illustrated 4-page brochure describes an extruder in models offering up to 75 lbs. per hour capacity in sizes of 1 to 6 inches, and lists manufacturing facilities for design, redesign, replacement, development, etc. Killion Tool & Mfg. Co. (104-D)

BLOW-MOLDING MACHINES. 4-page illustrated brochure describes automatic, high production blow-molding machines that mold parts to 14 in. in diameter, and 36 in. in length at dry cycle rates up to 14,000 parts per hour. Features, applications, complete specifications. Auto-Blow Corp. (105-D)

INJECTION MOLDING MACHINES. Literature offers comparison between ram and screw cylinders injection molding machines—a theoretical discussion between these two basic methods of plasticizing reprinted from Kunstoffe, combined with German Plastics Digest. Ankerwerk International. (106-D)

POLYOLEFINS. 16-page illustrated book describes family of unusual plastic materials made from gaseous olefins. Applications, features, complete list of properties, other data. Chemore Corp. (107-D)

AUTOMATIC PLASTICS MOLDING. 8-page data book contains an informative article on the economics of automatic thermoset molding (with case studies) and outlines a newly-expanded line of low-price, high-speed automatic molding presses. Advantages, features, specifications. Dake Corp. (108-D)

TEMPERATURE INDICATING MATERIALS. Illustrated folder describes line of crayons and paints for checking the temperature of any hot surface. Materials change their original color when specified temperatures are reached. How to use, applications, other data. Curtiss-Wright Corp., Princeton Div. (109-D)

CONVERSION TABLES. Folder contains over 800 factors—arranged for easy reference in alphabetical order. Makes any conversion a quick and simple process. American Cyanamid Co., Process Chemicals Dept. (110-D)

WHAT'S NEW IN PLASTIC. Sept.-Oct. issue of Durez house organ offers notes on product improvements in the plastics field. Includes data on carpet sweeper, "switchless" switch, plastic luggage, etc. Hooker Chemical Corp., Durez Plastics Div. (111-D)

TETRAHYDROFURAN. 14-page illustrated book describes solvent for a majority of synthetic and natural resins. Covers solvent power, evaporation and diffusion rates, physical properties—including charts of vapor pressure and density. Includes uses, product information, other data. E. I. du Pont de Nemours & Co., Inc., Electrochemicals Dept. (112-D)

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HYDRAULIC PRESSES. Illustrated brochure describes complete line of hydraulic presses including hot plate, forming, gap, and special purpose presses. Complete specifications, important features, other data. Ferracute Machine Co.; A. B. Farquhar Div. (114-D)

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MOLDING MATERIALS. 22-page book describes diallyl phthalate resin for molding materials that offers superior dimensional stability, high electrical property retention, color retention, chemical resistance. Food Machinery & Chemical Corp., Chemicals & Plastics Div. (116-D)

STABILIZERS. 40-page stabilizer handbook covers recommendations for rigids, flexible vinyls, plastisols and organosols, expanded vinyls, etc. Includes discussion of special problems, laboratory testing, and table of conversion factors. Ferro Corp., Chemical Div. (117-D)

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FIBERGLAS REINFORCEMENTS. 30-page illustrated book covers the story of fiberglas reinforcements for the plastics industry. Discusses chopped strand mats, molding methods, pre-mix molding compounds, applications, etc. Glass Yarns & Deeside Fabrics, Ltd. (119-D)

PLASTICS CONVERTING MACHINES. 6-page illustrated folder describes various types of machinery—including equipment for coating fabrics, paper, foil, etc., with all kinds of plastics. Photos, general information. Hofmann & Schwabe KG. (120-D)

SHEET TESTER. 16-page illustrated book describes new thermoplastic sheet tester for thermoforming. Includes description of the stretching process, practical measurement, and summary. Photographs, schematic diagrams. Hydro-Chemie. (121-D)

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PLASTICS MACHINERY. Catalog describes complete line of machinery for rubber and plastic industries. Covers mixing mills, calendering equipment, extruders, spreading machines, etc. Iddon Bros., Ltd. (125-D)

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AUTOMATIC BOILERS. 4-page illustrated folder describes packaged automatic boiler that offers positive circulation, side-located furnace, ideal flue gas travel. Complete description of features, advantages, specifications and dimensions. Orr & Sembower, Inc. (131-D)

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PLASTICS DESIGNING. 11-page illustrated brochure discusses basic rules and techniques for designing plastic parts. Covers such subjects as taper, wall thickness, threads, parting line, knurling, etc. American Insulator Corp. (141-D)

SPECIALIZED RESINS. 56-page illustrated book describes line of specialized resins. Includes general information on plasticizers, stabilizers, colorants, fillers and lubricants. Also discusses pre-blending, mill-mixing, calendering, suggested basic formulations, etc. The General Tire & Rubber Co., Chemical Div. (142-D)

VINYL PLASTICS. 16-page illustrated book describes polyvinyl chloride resins. Includes information on plastics for wire and cable, rigid extrusions, flexible extrusions, molding, foam and sponge, plastisol molding, etc. B. F. Goodrich Chemical Co. (143-D)

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portioning? If so, can they be compensated for conveniently?

7. If air power is used, are the air lines leak-proof? If closely regulated air pressure is required, is such regulation available?

8. If need be, can compound be conveniently drawn off for a separate application, without going through the catalyzing and dispensing system?

9. Does the machine have adequate temperature controls and indicators?

10. Will the machine allow a convenient check on the material proportions for purposes of process control?

11. Is a flow meter or a flow indicator provided to rapidly indicate clog-ups?

12. Is the machine simple to operate? Will it require excessive maintenance?

13. Does the manufacturer provide adequate instruction manuals, spare parts list, and other services?

14. What are the limits of accuracy, precision, and sensitivity for the proportioning system?

15. Will the equipment handle the range of dispensing rates and volumes which will be required for the service contemplated?

16. Does the machine dispense continuously or does it dispense intermittently, thus requiring charge-up time? How much does this charge-up depend on compound viscosity? Will this slow down operation?

17. Does the mixing head or system provide thorough and uniform component mixtures?

One should not ask for more performance than is required, as equipment and maintenance costs will likely increase proportionately.

Curing ovens

After parts have been embedded, the potted assembly is usually placed in an oven to complete the cure of the resin. Although batch-type ovens have been, and continue to be, predominant for curing compounds in embedment processes, conveyorized ovens are used in many cases. Which of these two types are best to use will depend somewhat on the specific operation. Nevertheless, there are certain factors which should be considered in making a choice. First, a conveyorized oven should be considered before automatically buying batch-type ovens. In many cases it may be that a conveyorized oven will not be too expensive, especially when compared with the cost of some of the large batch ovens.

One of the things governing the choice of oven will be the curing cycle. If the curing cycle is very long, then a very long and large conveyorized oven will be required. The size of the conveyorized oven can be minimized by using the slowest possible belt speed; yet there is a limitation on how slow a belt can go. Also, a new oven will be needed if longer curing cycles are ever desired. For instance, a 4-hr. cure would require an oven 10 or 12 ft. long even if the belt speed were so slow its movement were barely perceptive. Hence, for a 12- or 24-hr. cure, a conveyorized oven might be quite impractical. For batch type ovens, long cure cycle will involve either a very large oven or several smaller ovens.

In all cases it is best to compare

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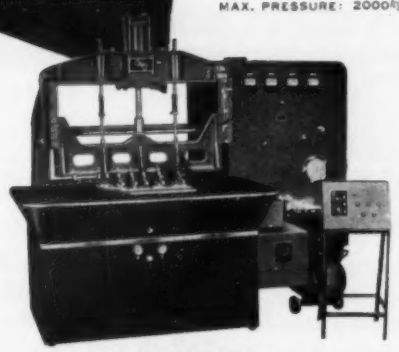

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Not too long ago our Oxiron epoxy resins were new-born in the laboratory. The possibilities were exciting. Here was a new kind of epoxy, an epoxidized polyolefin, with a far greater number of reactive sites in the molecule than conventional epoxies. The resin showed outstanding heat distortion characteristics, chemical resistance, versatility in cure.

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We've just taken a long step in the direction of competitive pricing, thanks to new facilities for producing Oxirons on a semi-commercial scale. Further economies are anticipated at large scale production. Even now, our new price for car load quantities of Oxiron may give you an economic advantage in the products you make.

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1. New low price: Here's the large-quantity schedule —

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2000	65¢	75¢
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the costs of conveyorized ovens against batch ovens relative to the job to be done and other process conditions. If floor space is a major consideration, then a conveyorized oven might be ruled out, as a batch type oven normally requires only overhead space, whereas, a conveyorized oven extends over the floor area. This is not always the case, since other designs are possible. For example, the conveyorized oven can be mounted directly between, and adjacent to, the resin mold-filling station and the station where mold separation and finishing operations are located. The conveyor-oven, then, both cures the compound and transports the part. This eliminates cluttering the area with hand trucks and other transfer equipment. A typical conveyorized oven is shown in Fig. 7, p. 112.

For either type of oven, circulating hot air is recommended because of its uniform heating characteristics. Non-uniform heating can result in different rates of polymerization. This can result in voids or other surface defects.

Oven air can be heated either electrically or with steam. Sometimes steam is preferable when there is a chance of igniting solvent vapors. However, electrical systems usually need less maintenance, are often more uniform, and are successfully used in many cases. In any case, the ovens should have adequate recording-type temperature controllers and indicators. This allows the study of variations in temperature and their possible effect on the cure of the resin.

With conveyorized ovens, mesh or roller type conveyors should be used. Solid-belt conveyors can have a thermal insulating effect on the base of the part being transported through the oven. This can lead to an uneven temperature gradient, a differential curing rate, and the associated problems already mentioned. Also, solid-belt conveyors are difficult to clean when compound is spilled on the belt, as is often the case.

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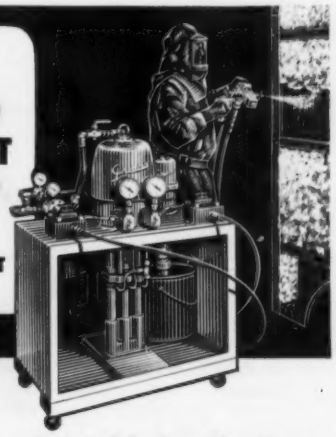

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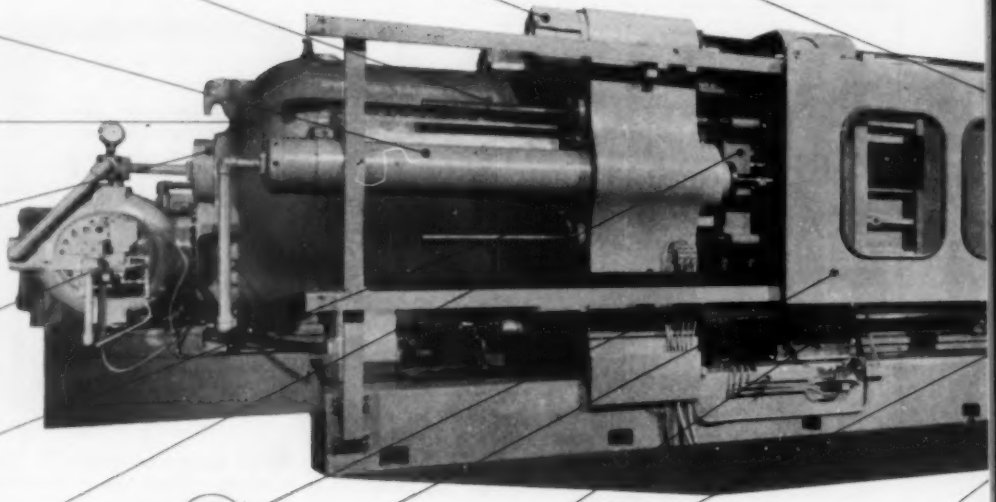

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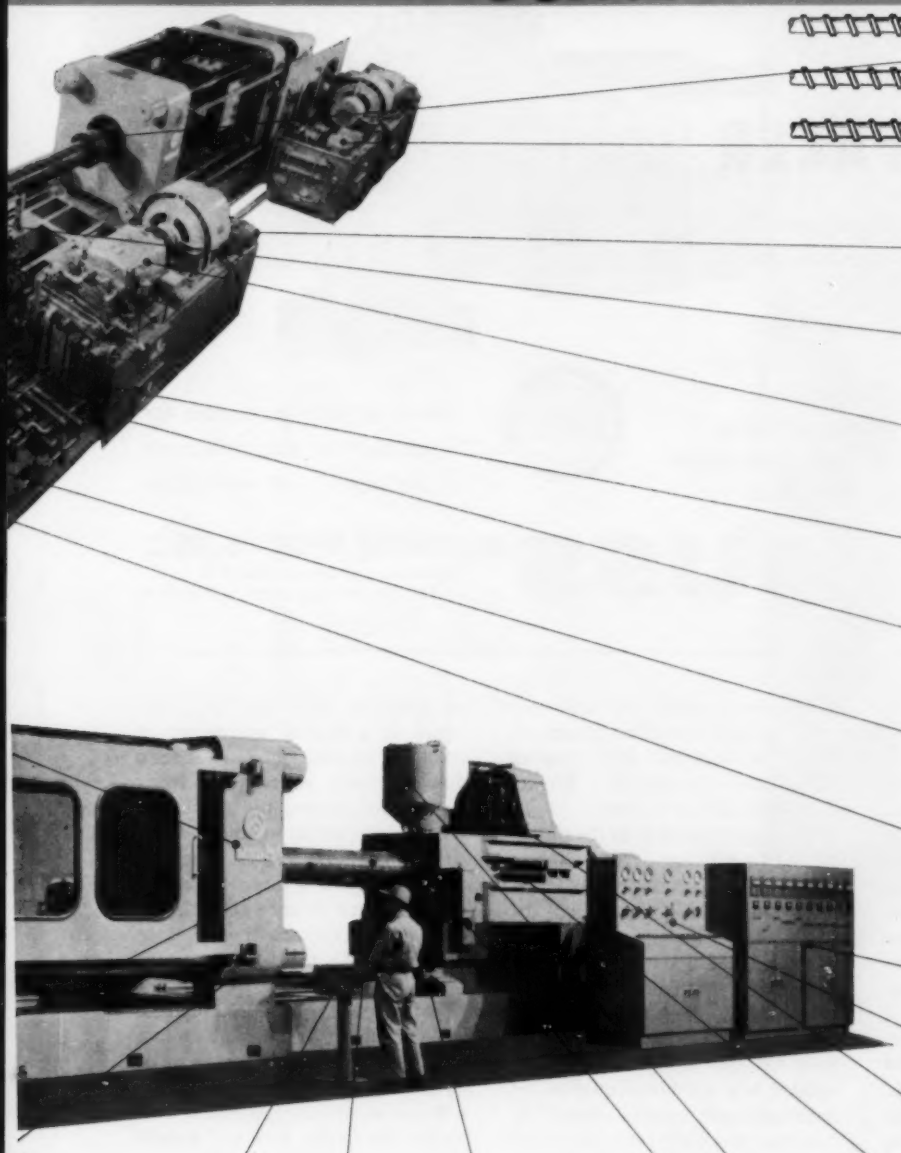

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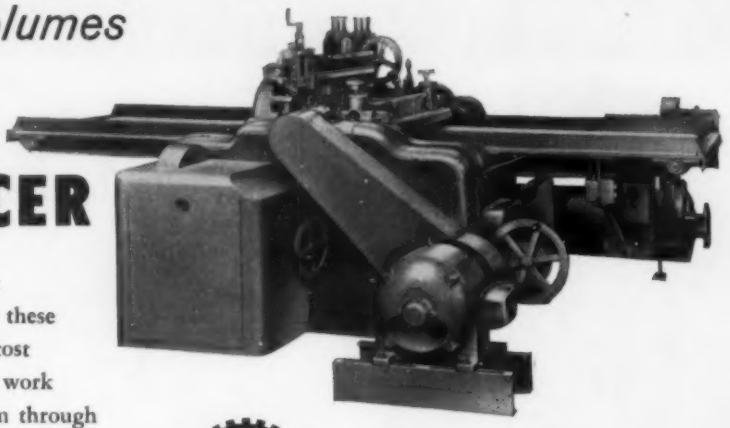

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Resin cure

(From pp. 117-120)

tractables other than resin in the phenolic prepreg could introduce errors in the index numbers so determined. The error would arise from the presence of materials which had a more limited solubility in the acetone-water mixture than does the phenolic resin. Fortunately, most phenolic prepregs do not generally have this type of ingredient and if by chance they were present, the amount present in the 4% solids solution would not significantly affect the end point or the index number, being in practically all cases a negligible factor. Moreover, since the amount of such other additives will not vary greatly and since the test is most often used to determine relative degrees of cure between two similar samples, any error would probably be constant and not materially affect any conclusions drawn from the results.

Studies have been conducted to determine the usefulness of this method. Various types of phenolic prepregs have been used and were found to show similar results. A study of Adlock 851 prepreg (American Reinforced Plastics Co.) was made as follows.

Prepregs of Adlock 851 were advanced to different degrees of cure and then the resin content, volatile content, resin flow, and the new index number were determined. The amount of resin solids and the ratio of resin flow to resin solids were then calculated. The reason that resin solids were used for this study is that resin content is a combined quantity of resin solid and volatile content. In this case, we were only concerned about the actual amount of resin. Since resin flow is a function of both degree of advancement and resin solid, then the ratio of resin flow to resin solid will give us an indication of the degree of advancement. The table on p. 120 presents the results of the study.

Fig. 1, p. 117, is a plot of the new index number vs. the ratio of resin flow to resin solids content. Considering the human error in testing, it is a narrow straight line as compared with Fig. 2, p. 117, which is a plot of percentage of resin flow vs. the same ratio of resin flow to resin solids. The index number, of course, will not be directly proportional to resin flow as shown in Fig. 3, p. 120. Since the index number is a direct indication of the degree of cure not affected by the resin content, then prepreg of any resin content will have the same index number as long as the resin has been advanced to the same stage. It is also found that a small amount of evaporation of acetone during the testing period will not negate the test result. This makes the testing easy and assures high precision and accuracy.

Another very important application of index number is as a control method for molding compound such as ½- by ½- in. chopped or macerated material.

The resin flow methods of molding compounds are not only inaccurate but again affected by resin content. Using the cure index number, molding compound can be evaluated and controlled to a definite stage of advancement.—**End**

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Adsorption

(From pp. 123-133)

of polyesters is shown in Fig. 7, p. 129. The results are typical for all the polyesters that we have studied. This particular material had a $\overline{M}_n$ (number-average molecular weight) of about 4000. It can be observed that at a concentration of 3.8 mg./ml. about five times as much polymer is adsorbed from the very poor solvent, toluene, as from the good solvent, chloroform. This may be caused, in part, by a smaller polymer molecule in the poor solvent, although small polymer molecules appear to lie much flatter on the surface than the very large polymers. It is also possible that different portions of the polymer are adsorbed from chloroform than from toluene.

Figure 8, p. 129, shows the results of the adsorption of poly(vinyl acetate), $\overline{M}_w$ (weight-average molecular weight) about 250,000, on iron from different solvents as reported by Koral, Ullman, and Eirich (2). The quantity of polymer adsorbed is in reverse order to the solvating effect of the solvent for the polymer. The intrinsic viscosity of the polymer in carbon tetrachloride (the poorest solvent) was 33 cc./g. and in chloroform (the best solvent) was 138 cc./g.

The density and the thickness of the adsorbed polymer layer would be expected to be closely related to the solubility of the polymer; that is, more solvent would be occluded in the polymer layer in the case of the good solvent. In addition, the extended polymer molecule in the good solvent may block potential adsorption sites. Cook and Ries (13) in an investigation of the adsorption of stearic acid concluded that six or more solvent molecules are carried to the solid surface by the stearic acid molecule. The authors postulated that the initially adsorbed molecules are adsorbed in a scattered fashion. As additional stearic acid molecules reach the surface, adsorbed solvent molecules, *n*-hexadecane, not in contact with stearic acid molecules, are quickly displaced. Those in contact are less easily replaced. In the case of adsorption from benzene, more complete coverage was obtained. This was attributed to the absence of a mixed-monolayer formation. The results of studies with small molecules should be applicable to the adsorption and solvent-adsorbate interaction of polymers.

Effect of molecular weight

An attempt was made to adsorb di-*n*-butyl sebacate, a small molecular weight ester (MW = 314), onto Type E glass and silica from several solvents. There was no measurable adsorption on the glass, but appreciable adsorption on the silica did occur. Negative results were also reported by Ullman and coworkers for the adsorption of linear dimers on glass (3, 14, 15). It is apparent, therefore, that the situation for adsorbing a very low molecular material from solution is markedly different from a polymer molecule of similar chemical structure. In general, beyond what may be some critical molecular weight, the amount of polymer adsorbed increases with molecular weight, although differences are not quite as large as might be expected.

Heller and Tanaka (16) studied the adsorption of polyethylene glycol fractions from water onto a porous carbon. They found an increased quantity adsorbed with increasing molecular weight, in the molecular weight range 300 to 6000, as shown in Fig. 9, p. 130. Although much smaller quantities of the monomer, ethylene glycol, were adsorbed, its structure is quite different from that of the polymers. Solubility may also be a factor in these results as there is decreasing solubility with increasing molecular weight.

When the moles of polymer per gram of adsorbent were plotted against molecular weight at a given equilibrium concentration, as shown in Fig. 10, p. 133, a maximum adsorption was observed at a molecular weight of 300, the lowest molecular weight polymer studied. Several factors are involved in the location of the point of maximum adsorption. It may be a real adsorption effect, that is, the configuration of the molecule at this molecular weight and its solubility in water and affinity for the adsorbent may be such that it has optimum packing and attractive forces at this molecular weight. On the other hand, the adsorbent is porous and smaller portions of the surface area may be available as the mo-

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lecular weight increases. Also, the adsorption of the monomer, as indicated earlier, may be very different from the polymer because the polar portions of the ethylene glycol molecule are relatively close together compared to the distance between the ends of the polymer chain. Therefore, the adsorption of molecular weight fractions lower than 300 may yield higher, rather than lower, values of the amount of polymer adsorbed per gram of solvent. This interesting problem needs further study, especially with nonporous adsorbents.

Koral, Ullman, and Eirich (2) found that adsorption is more dependent on molecular weight in a poor solvent than in a good solvent. According to the Flory-Huggins solution theory, the solvating power of a solvent for a polymer decreases with increasing molecular weight of the latter. This effect is emphasized in a poor solvent. There is a greater tendency, therefore, for the higher molecular weight material to separate from the solvent and adsorb on the solid. Although the weight of polymer adsorbed increased with molecular weight in a manner similar to that described by Heller and Tanaka (16), there was not a preferential adsorption of the larger molecules. In fact, the number of chains adsorbed decreased with increasing molecular weight. If a polymer were to lie flat on a surface, and remain so until a monolayer is formed, then the weight adsorbed would be independent of molecular weight. In the other extreme case, if the polymer were to be attached to the solid at one point only, then the number of chains adsorbed should be independent of molecular weight. The molecule may be attached at several points along the chain, with loops or bridges extending into the solution. The interactions and compressions of the polymer coils as they adsorb will be discussed later.

The preferential adsorption of one molecular weight species over another has been the subject of some discussion. It appears that the problem, in part, may be related to differences in the rate of adsorption of these different species. Frisch, Hellman, and Lundberg (11) concluded that the higher molecular weight polystyrene mole-

cules were preferentially adsorbed at apparent equilibrium. They attributed the variance in the results of Hobden and Jellinek (6) and others to the shorter adsorption times used by the latter. Frisch *et al.* were able to reproduce the molecular weight dependence of Hobden and Jellinek by the use of shorter times, inferring that smaller molecules are initially preferentially adsorbed and are slowly replaced by larger molecules.

Miller and Pacsu (17) in a study of the fractionation of cellulose acetate by adsorption on porous carbon reported that smaller molecules were preferentially adsorbed and that there was not subsequent replacement of adsorbed molecules by either smaller or larger unadsorbed molecules.

Yeh and Frisch (5) carried out some interesting experiments in which they chromatographically fractionated by an adsorption-desorption procedure a mixture of different molecular weight polystyrenes. The chromatographic column was packed with activated charcoal mixed with an inert material. The mixed-MW polymer solution was added to a column of the adsorbent and then eluted with solvent. Various solvent and elution combinations were used.

Figure 11, p. 133, shows the results of one such experiment. The polystyrene mixture was adsorbed onto the carbon from a poor solvent, methyl ethyl ketone. It was then eluted with this same solvent. No desorption occurred with this poor solvent and no polymer was observed in the effluent. Following this, toluene, a better solvent, was used as the eluent. The toluene eluted a small portion of the lower molecular weight polymer, with the lowest molecular weight material coming off first. The solid lines refer to the molecular weight and the dashed lines to the quantity of polymer eluted. After no more polymer was removed by the toluene, the solvent was changed to Tetralin, an excellent solvent for polystyrene. The larger portion of the polymer was removed by the Tetralin; the MW increased with each fraction. About 77% of the polymer was recovered.

If elution is considered the reverse process of adsorption, then the better solvent should elute more polymer than the poor solvent. Simha, Frisch, and Eirich (18) showed by statistical considerations that high molecular weight polymers will be more strongly adsorbed than lower ones. It is possible that the lower molecular weight polymer may be desorbed by the toluene, but may be partially entangled within the flexible coils of the higher molecular weight portions. The toluene may not be a sufficiently good solvent to cause the higher molecular weight coils to expand to free the low molecular weight portions. The Tetralin is a sufficiently good solvent to expand these coils, free the low molecular weight material, and then desorb the higher molecular weight portions. The fractionation observed can be attributed to either weaker bonds formed by the low MW material with the solid or to the more ready solubility of the low molecular weight portion in a solvent, or both.

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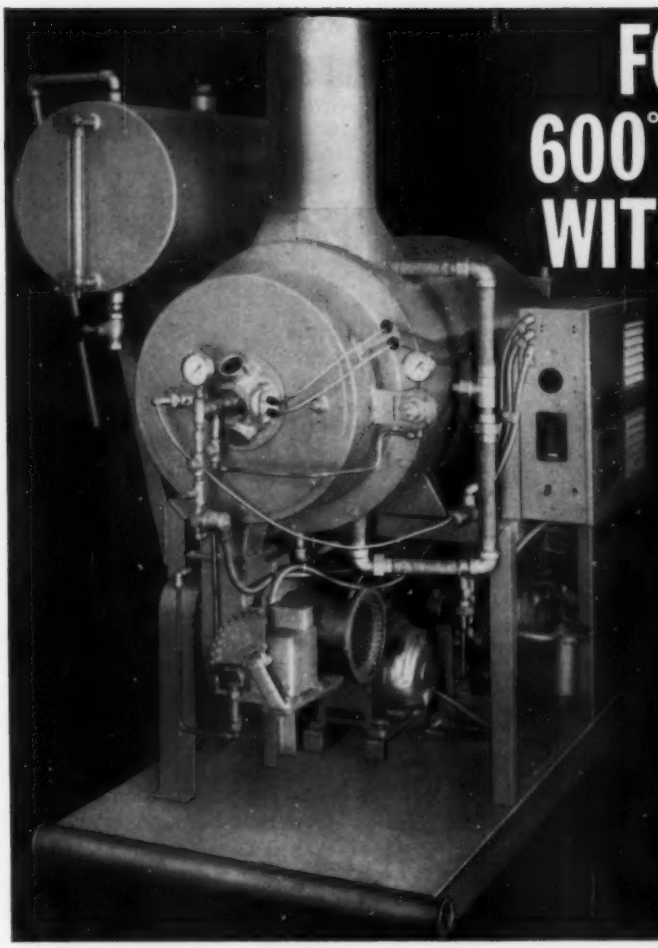

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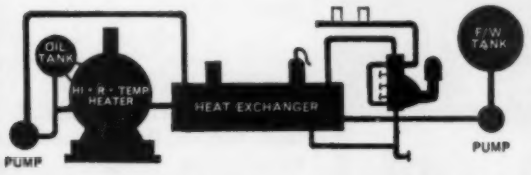

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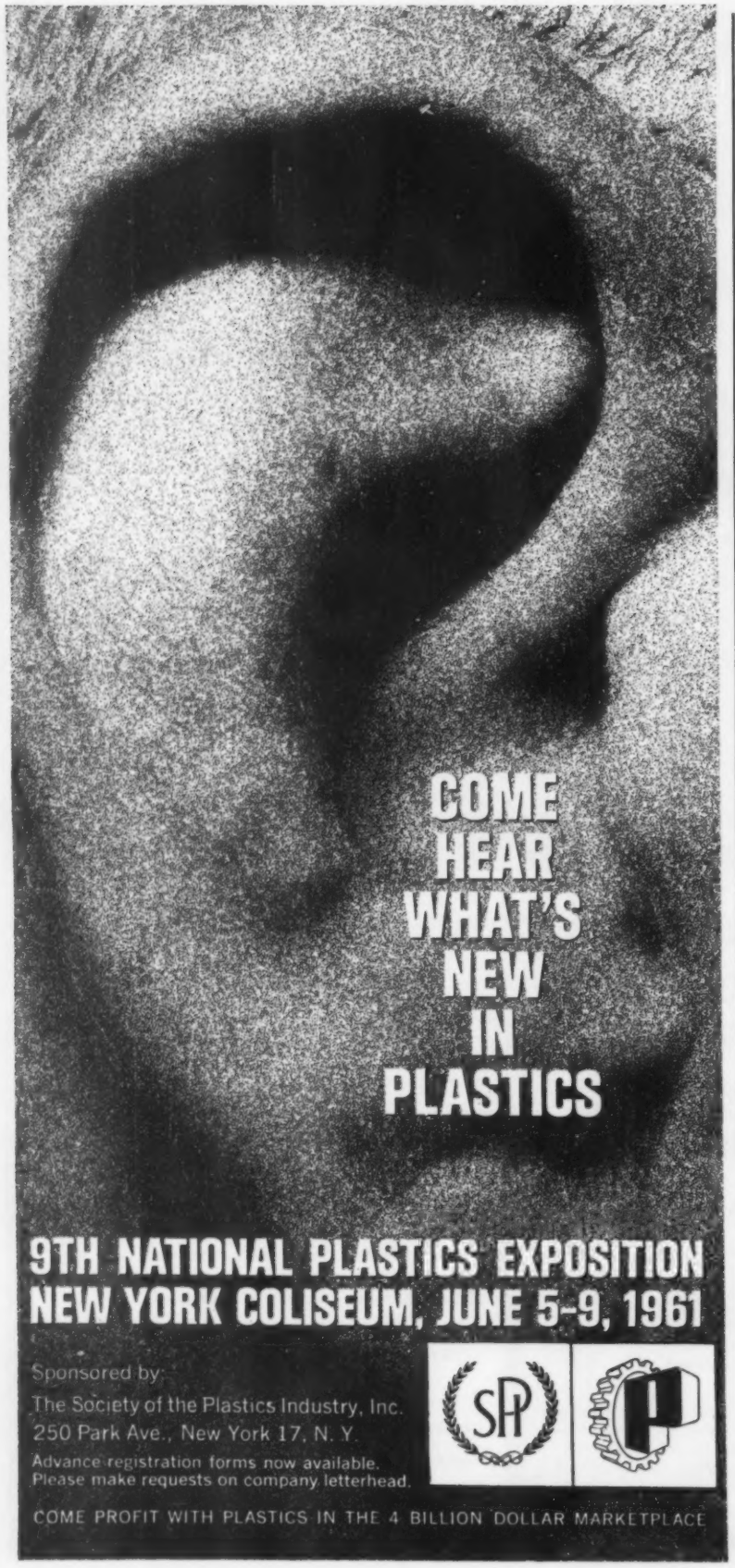

Polyolefin resins

(*From pp. 135-143*)

epoxidized polyolefin resins for printed circuits. Table VI and Table VIII present data on wet (hexahydrophthalic-glycol) and dry prepreg (Oxiron Curing Agent 300) formulations that have been used to prepare copper-clad laminates. It will be noted that both formulations show excellent peel strengths, 9.3 to 11.0 and 10.5 to 13.5, respectively. This supports a number of general observations that have been made attesting to strong bonding of epoxidized polyolefin resins to a variety of materials.

The authors are grateful to those members of our Application Research Laboratory of Food Machinery and Chemical Corp. that have made this article possible. Particular thanks go to J. J. Rizzo for supplying the high-temperature sample, to C. G. Cullen for the laminates, to F. Lister for work with Oxiron Cure Agent 300, to N. E. Talbert for some of the casting data, and to Dr. C. F. Ferraro and his group for making mechanical and electrical measurements.

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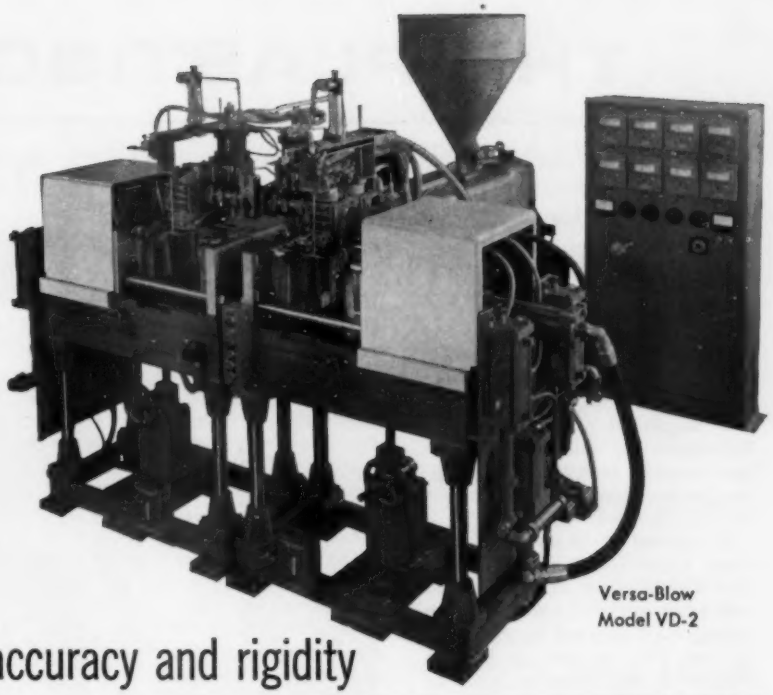

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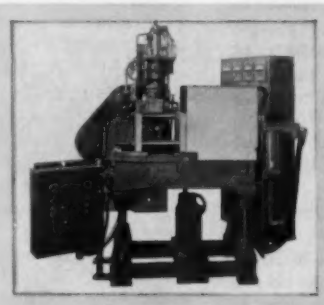

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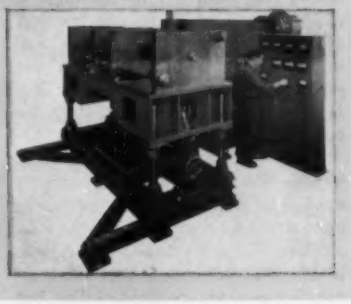

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THE PLASTISCOPE*

News and interpretations of the news — By R. L. Van Boskirk

Section 2 *(Section 1 starts on p. 41)* — **April 1961**

At last—laminate of Videne-plywood

After three years of development and research by Goodyear Tire & Rubber and U. S. Plywood, the latter has finally brought to market a plywood-Videne laminate which will sell to the tune of about $4 million a year, according to a report by the president of U. S. Plywood.

As reported in this magazine many times, Videne is a tough, clear, polyester film based on terephthalic acid and other materials. According to Goodyear, it will not shrink, craze, or crack with age and can be used outdoors as well as indoors. It can be laminated under heat and pressure to wood or wood composition materials in a one-step process. No catalyst or cure time is necessary. It eliminates the need for multiple coatings on a substrate. According to Goodyear, the laminate shows less wear than any other surfacing material, including high pressure laminates.

Videne is produced at Goodyear's plant at Point Pleasant, W. Va., in rolls of widths up to 54 in., in either a clear or satin finish and in colors. Gages run from 1.5 to 5.0 mils. It can be decorated by reverse printing, silk screen, flexograph, or other conventional processes. It is used for prefinished surfaces for paneling, kitchen cabinets, furniture, store fixtures, and similar uses.

U. S. Plywood officials say that Videne film may eventually surpass the use of paint in factory prefinishing. Average cost of U.S.P.'s new product, called Weldwood Permagard, is said to be 20% more than the company's top grade prefinished line but "considerably less" than architectural grade wood paneling that must be finished on the job.

Disposable dishes and cookware

Haveg Industries Inc. has announced formation of a Hav-A-Tray Div. to manufacture a new line of thin-wall reinforced plastic disposable dishes and cookware.

Hav-A-Tray containers are said to be suitable for frozen food packaging, catering services, hot food vending machines, and for heating, cooking, and serving foods; and they are claimed to have many improved properties over aluminum foil, waxed paper, vacuum formed plastics, and fiberboard containers in food handling, cooking, and serving. In addition, they may be hermetically sealed with a clear plastic film that can be imprinted and is resistant to boiling water.

Hav-A-Tray containers are said to be both heat and cold resistant and can be used in gas, electric, and electronic ovens at normal cooking temperatures (375 to 450° F.). With Hav-A-Tray containers, it is now possible to place hot foods directly into a deep freeze (—60° F.) and later transfer the same item to a hot oven without harmful effect.

Dr. John H. Lux, president of Haveg Industries Inc., states that Hav-A-Tray containers are priced so inexpensively they are a throw-away item; yet they are reusable and have withstood innumerable dishwashing cycles without showing damage or deterioration of any kind.

United Plastics Distributors after new members

The United Plastics Distributors Assn. is determined to "promote better understanding among ourselves, and strong confidence in our ability to act together to further mutual objectives . . . each member firm is expected to achieve prestige in the community each serves."

August Metz, manager of the Pittsburgh branch of Commercial Plastics & Supply Corp., recalled that the organization originally came together primarily to encourage the sale of new plastics products through plastics distributors. The organization is to serve as an outlet for the introduction of new marketing methods and effective sales policies that would benefit industrial buyers everywhere . . . to encourage the sale of the newer plastics products through plastics distributors, the natural suppliers to small and medium-sized industries. The UPDA's present membership, numbering about 20, must be expanded to fill the communications gap, Mr. Metz advised the members. "Each one of us must be a salesman promoting this 'exchange of ideas' to present members in the UPDA, even as we try to induce other interested distributors across the country to join our ranks."

New thermoplastic

The Pfizer organization has joined two European industrial organizations, Snia Viscosa, S.p.A. and Ledoga S.p.A., in ownership of Laboratori Italiani di Ricerca Chimica S.p.A (LIRC) of Milan, Italy, to conduct research and exploit commercial applications of itaconic acid, a versatile chemical first made available in commercial volume by Pfizer in 1955.

First LIRC products developed were two thermoplastic resins containing substantial amounts of dimethyl itaconate, the methyl ester of itaconic acid. Known as Dialux A and C, these molding compounds are being used in making plastic reflectors for automobiles and other vehicles. Because they have high weather resistance and high heat distortion temperatures, a Pfizer spokesman said the Dialux resins are also expected to find use in such products as outdoor signs, fluorescent light diffusers, and auto accessories. Other products based on itaconic acid now under development by LIRC include paint latices and varnishes. The chemical is used commercially in vinyl and acrylic copolymers. More than 300 patents have been issued covering such applications as synthetic rubber-like compounds, viscosity index improvers for lubricants, paint driers, adhesives, water-resistant glass coatings, photographic paper, moisture-proof cellophane, and gum tape adhesives.

Applications of itaconate esters include thermoplastic molding compounds and sheet, solvent coatings, acrylic emulsions for paints, paper coatings, leather coatings, and textile finishes. Other applications include water soluble thickeners, and heat-resistant elastomeric formulations.

Cold-proof polystyrene

First of a new class of impact polystyrenes for injection molding has been announced by Union Carbide Plastics Co. Characterized as medium-impact, the new product, Bakelite TMD-9020, is said to have shown in tests on thin-walled containers higher usable strength and toughness even

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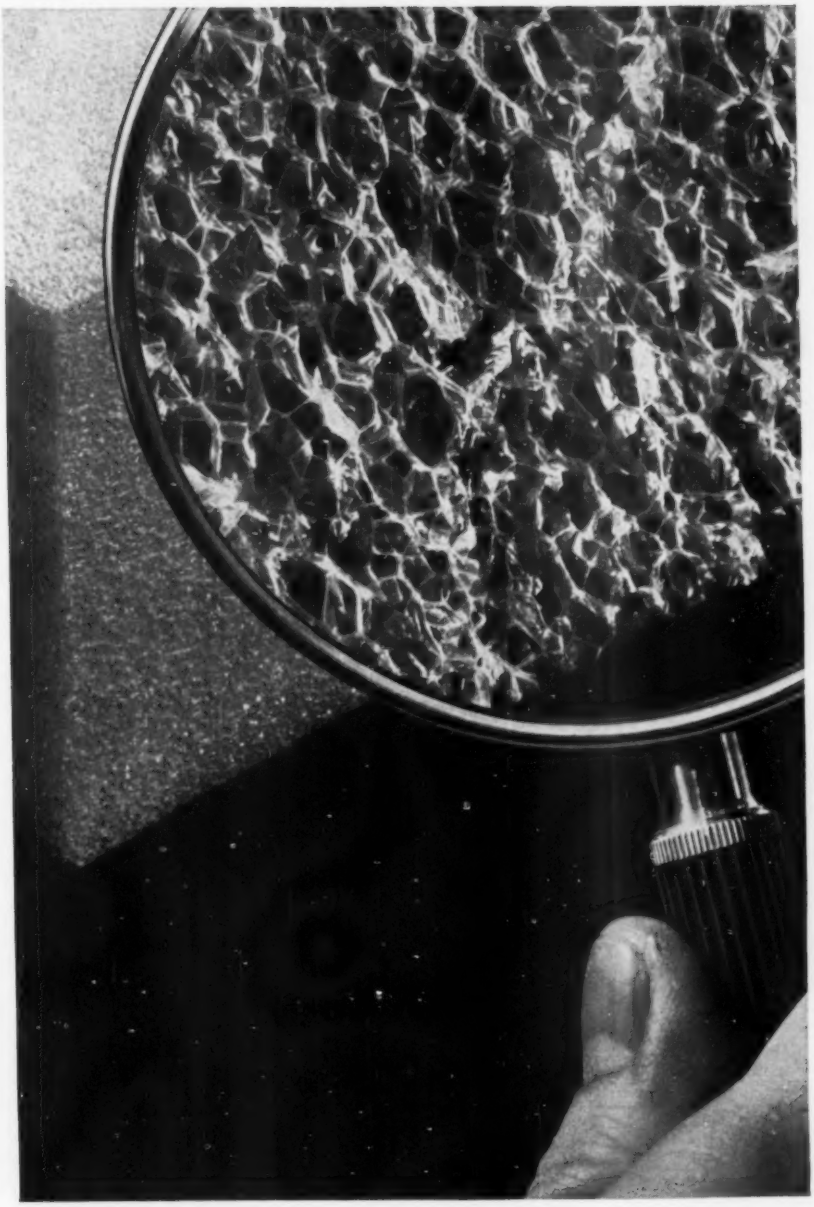

Styrofoam is Dow's registered trademark for its expanded polystyrene—Only Dow makes Styrofoam expanded polystyrene

Styrofoam is applied only to the homogeneous expanded polystyrene made according to an exclusive Dow manufacturing process that gives the material its unique physical properties.

Styrofoam is always spelled with a capital "S" because it's a trademark. It's *not* the name of a general class or type of material! And it does *not* refer to other foamed polystyrenes made by different processes.

"Styrofoam" identifies Dow's expanded polystyrene. For superior insulation and flotation applications be sure you specify and get Styrofoam brand. Styrofoam is exclusive with Dow—there is no such thing as a "substitute"!

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(From page 200)

at —20° F. than conventional medium-impact polystyrenes. Priced at 26¢/lb., TMD-9020 is available in a natural translucent form and in a series of pastel and opaque colors.

Polyether resins for foams

Commercial availability of Fomrez polyether resins for flexible urethane foams has been announced by Witco Chemical Co. Inc.

Based on propylene oxide, the new resins are polyether diols, ED-2000, and triols, ET-3000 and ET-4000. The number designations represent average molecular weight values.

High-viscosity epoxy

A new epoxy novolac, Experimental Resin X-2638.6, has been developed by The Dow Chemical Co. The resin has a viscosity in the range of 500,000 cp. compared to 120,000 cp. for D.E.N. 438, Dow's conventional epoxy novolac for high-temperature service. For handling ease, the material is available only as an 85% solution in methyl ethyl ketone.

Dow spokesmen say the high viscosity of this resin permits making prepreg fabric without the need for carefully controlled B-staging. Further, they suggest that users of such prepregs will find that matched-die molding under heavy pressures is possible without excessive resin flow-out. Prepreg tack is so slight, after solvent removal, that fabric webs can often be rolled and stored without an interleaving release film, says Dow development chemists.

Introduces epoxy line

Epoxy resins are now being introduced as a new line by Heyden Newport Chemical Corp. The new product line will include initially liquid and resinous curing agents for epoxy resins, and viscosity modifiers. Future products will be added to this family-line of specialties for other target markets. They will be made in new facilities at the Heyden Chemical Div. plant in Garfield, N. J.

New vinyl copolymer

Pliovic S-51, a vinyl chloride-vinyl acetate, low-molecular-weight resin, produced as a fine, white powder, has been developed by The Goodyear Tire & Rubber Co.'s Chemical Division. The new resin is particularly useful in producing rigid molded or extruded products under limited processing temperatures. It also produces good film clarity and handles easily on calendering and milling equipment, according to the company. Suggested for use in phonograph records, flooring materials, rigid and flexible calendered sheeting, and molded products, Pliovic S-51, produced at Goodyear's Niagara Falls, N. Y. chemical plant, will be marketed in 50-lb. multiwall bags and it is available in truckload quantities.

New polyester casting resin

Development of a modified polyester casting plastic, tradenamed Alplex, has been announced by Allen Plastics Corp., New York, N. Y. Shells or solid objects can be produced by adding a curing agent (MEK peroxide), mixing and pouring the formulation into rubber, plaster, or metal molds. Cast object can be removed from the mold within 10 to 20 minutes. No heating or cooling is required, the company claims. Since Alplex is a 100% solids material, there is said to be practically no shrinkage.

Suggested applications include models, displays, lamp bases, outdoor signs, garden ornaments, etc. Alplex is available in 55-gal. drums and in 1- and 5-gal. containers.

DAP molding compounds

Three new reinforced diallyl phthalate molding compounds have been introduced by Rogers Corp., Rogers, Conn. Each compound conforms with a government MIL specification.

RX 1260 is a flame-resistant, mineral-filled diallyl phthalate, free from magnetic particles. The material, which conforms to MIL-M-14E, Type MDG, is said to have superior moldability, particularly around metal inserts. No extender resins are used. It is recommended for electrical and electronic components such as connectors, terminal boards, etc.

RX 1280, generally similar to RX 1260 but compounded for temperature resistance up to 500° F., is a mineral-filled diallyl isophthalate molding compound which conforms to MIL-M-14F, Type MDG. The low mold shrinkage permits mold interchangeability with other high-temperature molding compounds, such as low-loss phenolics. It is not classed as flame resistant.

RX 1380, a glass fiber reinforced material in the isophthalate group, also offers temperature resistance up to 500° F. and conforms to MIL-M-14F, Type SDG. Claimed to have excellent electrical properties in the presence of moisture, high strength, heat resistance, and dimensional stability, it is recommended for critical insulation and structural applications.

PE film for construction promoted

Many persons are of the opinion that the reason for the comparatively slow growth of polyethylene film in the construction field is lack of vigorous promotion and poor distribution. The Kordite Co., Macedon, N. Y. film producer, is taking vigorous steps to overcome this inertia by inaugurating a widespread program to stimulate home builders' use of polyethylene sheeting in flashing, basement moisture proofing, and ceiling insulation. Dealers are being supported by a national direct-mail campaign describing the methods and advantages of polyethylene sheeting for head, sill, and joint flashing in homes under construction.

Auto body repair compound

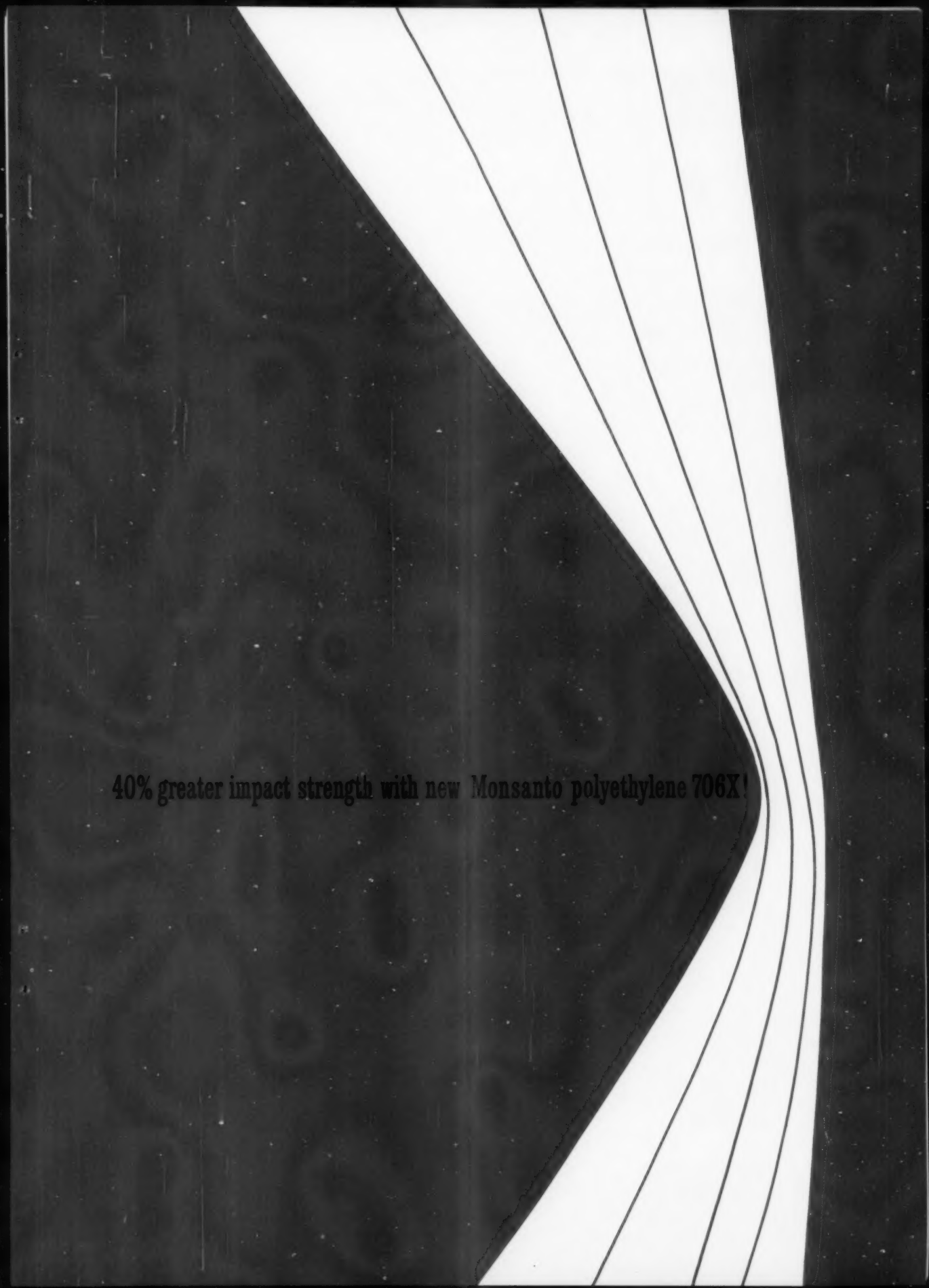
A filler said to reduce dust problems by as much as 80% in plastic auto-body repair materials has been introduced by Plastics & Chemicals, Chicago Ridge, Ill.

Dust has always been a serious problem in auto body shops. Almost impossible to control, the dust from clay or talc in old style fillers contains glass fibers which in addition to being difficult to remove from many surfaces, also are regarded as a menace to health. The reinforcement filler, which is used by P&C in making Plasti-Bodi repair compound, is a hydrous magnesium silicate of extreme fiber length. This filler is very bulky and quite absorbent and less is used to adjust resin viscosity (either polyester or epoxy). The filler, when hardened, emits a larger dust particle when polished with high speed grinders. The new product is said to eliminate 80% of the dust resulting from grinding and finishing after the filler has been allowed to set. It is applied in the same manner as old room-temperature curing putties and with the same equipment.

Penton-clad steel pipe

American Vulcathene Div. of The Nalge Co. Inc., Rochester, N. Y., has announced that it will handle sales and distribution of a new line of corrosion-resistant process piping.

The steel pipe, fittings, pumps, and valves, products of York Industrial Plastics Inc., York, Pa., are clad inside and out with Penton, a chlorinated polyether resin developed by Hercules Powder Co. This new sys-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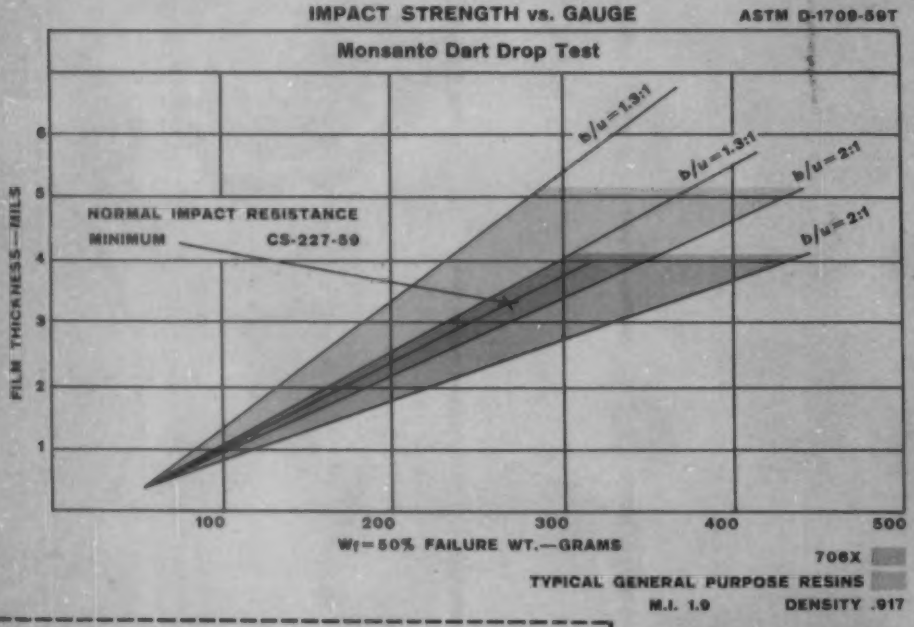

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(From page 202)

tem combines the strength of steel with the chemical resistance of Penton. A different coating process makes the Penton more adherent to the steel than usual methods.

Butyral sheet

Equipment to produce 60-in. widths of Shadowlite Saflex polyvinyl butyral sheet in 0.015-in. thickness has been installed by Monsanto Chemical Co.'s Plastics Division. Pigmented with carbon black, the material is used as an interlayer in laminated architectural safety glass for controlling solar energy in buildings with large glass areas. Total solar energy excluded is said to range from 19 to 42%, depending on the type of butyral film used.

Laminated architectural glass made with Shadowlite has been used in schools, office buildings, and factories for more than 10 years, according to the company.

Methacrylate in new colors and larger size

Rohm & Haas Co. has added eight new outdoor-stable shades to its line of colors for Plexiglas methacrylate sheet. Available as standard colors in the most widely used sheet sizes, the new colors may also be obtained on a custom basis in the company's newly announced extra-large size methacrylate sheet. The two new sizes, 8- by 12-ft., and 8½- by 12-ft., are offered in standard colors as well as in the colorless transparent form, in a thickness range of 0.125 in. through 0.500 inches. Rohm & Haas states that the giant size sheets are offered to meet increasing demand for larger plastic sign faces for internally illuminated signs, and for methacrylate plastic dome skylights and other architectural uses.

Colored magnetized vinyl

Previously available only in a basic brown hue, Koroseal vinyl magnetic strip is now being produced in nine standard colors by B. F. Goodrich Industrial Products Co. The strip can also be manufactured to meet any color specification. It is the first flexible magnet to be offered in a full range of colors, according to the company. Colors are obtained with a vinyl paint coating which becomes an integral part of the magnetic strip. Color is expected to encourage expanded use of the product in the field of toys, signs, advertising displays, visual aids, and novelty applications.

The Koroseal flexible magnet was developed originally for use in refrigerators to form an airtight seal around the entire perimeter of refrigerator doors, thus eliminating the need for a latch. More than half the cabinets now being produced employ flexible magnets.

Potential markets for the flexible magnet are limitless. Thousands of feet of the material have gone into the manufacture of levels for plumbers and metal workers. Other typical uses include dustproof garment bag closures, restaurant menus, storm door gasket-and-latch, and a variety of holding devices.

Economy-grade Teflon tape

The Joclin Mfg. Co., Wallingford, Conn., has announced the availability of Fluorolin 101-R tape, which is said to save 30 to 40% in the cost of Teflon pressure-sensitive tape. According to the company, 101-R can be used for outer protective wrappings, non-stick surfaces, and for wear strips. It is claimed to be an excellent release material for molds in the plastics and rubber industry; for calender rolls and equipment in the baking and food industry; and for abrasion resistance and corrosion barriers in the shoe industry.

Magnetic tape by Eastman

Eastman Kodak Co. will start manufacture and sale of triacetate-based magnetic recording tape later this year. Initially the tape will be supplied for sound recording uses. Sales to amateurs will be through Kodak's regular distribution organization. The professional motion picture sales division of the company will handle distribution to the professional trade.

Kodak has for some time been interested in the tape field in the United States as a supplier of Kodapak plastic sheeting for use by other tape manufacturers, and will continue its investigation of a range of magnetic tapes for instrument recording and electronic computing.

USA exhibition in USSR

Negotiations are in progress with Soviet authorities concerning exact dates and other details relative to the exchange of exhibitions between the Soviet Union and the United States. The Plastics-USA exhibition, which the U. S. Information Agency is assembling for showing in the USSR, is scheduled, subject to confirmation by the Soviet Union, as follows: Kiev, May 15-June 4; Moscow, July 1-21; Tbilisi, Aug. 11-Sept. 1.

Reichhold earnings

Reichhold Chemicals Inc., White Plains, N. Y., reported consolidated sales of $99,173,000 for 1960 and $100,924,000 for 1959. Net income for the year was $3,352,000 and $3,832,000 for 1959. All figures include the financial results of the Alsynite Co. of America and Deecy Products Co., which were combined during 1960 through pooling of interest. Earnings per share for 1960 were 86¢ based on an average of 3,829,000 shares outstanding and $1.08 for 1959 based on an average of 3,491,000 shares outstanding.

Epoxy-film adhesive

A new dry adhesive, for use in high strength, metal-to-metal bonding applications, Metlbond 408, has been introduced by Narmco Materials Div., Narmco Industries Inc., a subsidiary of Telecomputing Corp. The new material has been qualified as a Type 1, Class 11 sandwich adhesive under MIL-A-25463, and as a metal-to-metal bonding agent under MIL-A-005090D.

Metlbond 408, a 100% solids, modified epoxy resin system in film form, is supplied in continuous rolls 18 in. wide. To effect a bond, the sheet of dry film is cut to shape and placed directly between the metal surfaces to be bonded and cured at 350° F. for 1 hour. No post cure is necessary. Pressure has only to be enough to keep the parts pressed firmly together during the cure cycle.

Blue peroxide-stable dye

Perox Blue 2R, manufactured by Patent Chemicals Inc., Paterson, N. J., is believed to be the first soluble blue organic dye available for coloring plastic materials which are polymerized with organic peroxides. The new dye is completely stable to the peroxides.

Perox Blue 2R imparts a bright, transparent hue to the plastic resins. When combined with white substrates, brilliant pastel shades can be obtained. The new dye has good heat resistance and light fastness. It is recommended by PCI for polyester resins and for creating transparent shades in polystyrene and other thermoplastic materials, and as suitable for dope dyeing cellulose acetates.

Curing agents for epoxies

Three new flexible curing agents for epoxy resins are now produced by The Dow Chemical Co. They are de-

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scribed as amine-terminated aliphatics with controlled as well as limited functionality.

Experimental Hardeners X-3483.1, X-3483.2, and X-3483.3 are very-low-viscosity, almost colorless liquids. Dow spokesmen suggest their use to control flexibility, viscosity, and exotherm in both conventional epoxy resins and Dow's new flexible epoxy resins. Particular application in epoxy coatings, castings, adhesives, and laminates is expected.

Non-dusting dry colors

Dry color pigments that will not dust or separate from resin granules after mixing have been developed by the Color Div. of Ferro Corp. The new colorants are available in any color for all granular thermoplastic resins.

The non-dusting pigments substantially reduce the hazard of color contamination, the company claims, and make for easier cleaning of tumbling drums, hoppers, and other equipment. Because of the superior adherence of the pigment to the resin granules, pneumatic devices may now be used to transfer the resin-colorant mixture from the tumbling equipment to storage or hoppers. The new colorants enable the molder to combine the ease and convenience of compounded colored resins or master batches with the greater economies of the dry color process.

Cidal additive

Permachem Corp. research laboratories, in conjunction with two university research teams, has developed methods of incorporating permanent germicide-fungicide formulations in most forms of plastic, including polyvinyl chloride, polyethylene, polypropylene, urethane foams, and plastisols, according to the company. Once the additive is mixed with the plastic it will not leach out but is said to become an integral part of the plastic.

Applications include pipe covering, swimming pools, telephones, boat covers, vinyl film textiles, toys, sporting goods, furniture, and notions (combs, brushes, umbrellas, etc.). The price of the additive varies with the type of plastic being treated and ranges between 1¢ to 2¢ per lb. of finished plastic material. The material can also be sprayed on a finished product but is only permanent when incorporated in the compound.

Harte & Co. featured a treated vinyl-covered baby mattress at the Permachem display at the Plaza Hotel in New York last January. Other companies claimed by Permachem to be treating plastics are: Kaye-Tex, Presto, Goodrich, Ross & Roberts, Lyntex, Bambro, Hedwin, and Elm Coated Fabrics.

Lower price for FMC epoxies

A reduction in price for volume amounts of Oxiron epoxy resins announced by Food Machinery & Chemical Corp. makes these materials competitive with epichlorohydrin-based epoxies on a quantity basis.

Oxiron 2002 is now listed at 60¢/lb. in car load quantities (in drums); Oxiron 2001 at 80¢; and Oxiron 2000 at 65 cents. Since their introduction last year, Oxiron resins had been available only at developmental prices ranging from $1.75 to $2.25.

Epoxidized polyolefins rather than conventional epichlorohydrin - based condensates, Oxiron resins offer potential formulating economies because of their better volume/lb. ratio and their ability to use higher proportions of low-priced curing agents.

Patent for Benzoflex

A U. S. patent covering the chemical composition for the plasticizer, Benzoflex 9-88, has been awarded to Tennessee Products & Chemical Corp., Nashville, Tenn. The patent rights include dipropylene glycol dibenzoate as a composition of matter, and its use as a plasticizer with vinyl resins. They also cover methods for the manufacture of dibenzoate esters involving the reaction of benzoyl chloride with polyalkylene glycols. Benzoflex plasticizers are used with vinyl chloride. Two substantial plant expansion programs have been effected at the company's Chattanooga chemical center within the past two years to keep in pace with increased demand.

The chemical composition for Tennessee's Benzoflex 9-88 is derived from toluene and propylene oxide. The company reports that Benzoflex is in favorable competitive position with the more common esters of phthalic anhydride ester plasticizers derived in part from naphthalene.

Source for vinyl foam

Vinyl foam slabstock is currently available in 5 to 12 lb./cu. ft. densities, in fine to coarse textures, from Micron Chemical Products Corp., 740 Court St., Brooklyn, N. Y. The foams are heat sealable and are said to have extreme flexibility, uniformity of structure, and lack of blow holes. Shipments from stock can be made in several standard formulations in a variety of colors. Applications are as filler material for purses, hatboxes, wallets, etc., and as bottom foam for place mats and coasters.

More bottles

Owens-Illinois Glass Co. has announced a new plant for the manufacture of blown plastic bottles in Jersey City, N. J. Start of production has been set for next summer. The plant will be the sixth plastic bottle plant opened by O-I since it introduced the high-density polyethylene bottle three years ago. Others are in Kansas City, Mo.; Los Angeles, Calif.; Chicago, Ill.; Cincinnati, Ohio, and Toronto, Canada. The bottles are also produced at Owens-Illinois closure and plastics plants in Glassboro, N. J., and St. Charles, Ill. Owens-Illinois makes other plastic containers at plants in Riverdale, N. J., and San Jose, Calif.

Vacation house

Beckman Construction Co., Fort Worth, Texas, has acquired the manufacturing rights of Zygo Engineering and Mfg. "Spectrum," a fibrous glass vacation house. Zygo also manufactures Zylite, a decorative and light diffusion fibrous glass sandwich panel. Manufacturing rights for this have been acquired by Plastrend, a new company that is being formed in Fort Worth.

Glenn C. Grimes, president of Zygo, has resigned to become chief engineer of Honeycomb Co. of America, Bridgeport, Conn. In April, 1960, he formed Zygo in Fort Worth.

Plastics in Polaris

The Navy's new A-2 Polaris missile has a motor case constructed of 267,930 miles of continuous glass filament—enough to reach to the moon. The material, called Spiralloy, a combination of glass filaments and resin binder, is manufactured at Hercules Powder Co.'s Rocky Hill, N. J. plant by a filament winding process.

Vinyl fabrics in 1960

Shipments of supported vinyl fabrics in 1960 by members of the Vinyl Fabrics Institute showed an increase of 10% over the year 1959. This was the peak volume year for the industry. A total of 104,594,000 linear yards was shipped. The volume has grown from around 80 million in the middle 1950's.

Shipments of pyroxylin-coated fabrics and unsupported vinyl sheeting showed declines of 5 and 15%, respectively, in 1960 compared with

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(*From page 206*)

1959. A total of 20,400,000 linear yards of pyroxylin-coated fabrics and 31,706,000 sq. yd. of unsupported vinyl sheeting were shipped. Pyroxylin was 28 million in 1956. Unsupported has dropped from 48 million in 1956.

These figures, released by the Vinyl Fabrics Institute, represent information supplied by 20 firms participating in the statistical program. While they represent the industry trend, no attempt is made to estimate what percentage of industry-wide production is included. The figure on unsupported film is thought to be particularly low since several large producers do not report.

Commercial standard for PVC pipe

Prepared in cooperation with The Society of the Plastics Industry Inc. by the Commodity Standards Div. of the U. S. Dept. of Commerce, a recommended Commercial Standard, designated TS-5523, for Schedule A Type I and Schedule A Type II polyvinyl chloride pipe was recently submitted to the industry for consideration and acceptance.

The recommended Standard covers outside diameters and tolerances; minimum and maximum wall thicknesses; inspection procedures; and identification markings for 11 sizes of lightweight PVC pipe.

Limited copies of the recommended Standard are available from Commodity Standards Div., U. S. Dept. of Commerce, Washington 25, D. C.

Patent for sand-coating process announced

A patented sand-coating process that is regarded by the company as one of the first major improvements in the art of shell molding since its adoption by the American foundry industry has been announced by Durez Plastics Div., Hooker Chemical Corp., North Tonawanda, N. Y. According to the company, the process, using standard equipment, simplifies resin-coating procedures, permits use of either powdered phenolic resins or resin solutions for sand-coating purposes, and can be conducted cold or accelerated with hot air. Unlike other methods, the process involves no chemical reactivity. As a result, duplication of batches and product control are simplified.

The new method involves mixing sand, powdered resin, alcohol, and water in controlled proportions or a predissolved solid resin in a mixture of alcohol and water. The alcohol serves as a solvent for the resin, resulting in a liquid that thoroughly coats each particle of sand in the mixing or mulling process. The addition of water increases the flash point of the vapor given off during the drying cycle, thus reducing explosion and fire hazards; speeds up the solvent evaporation rate; and decreases packing tendencies of the dry coated sand. The dry, resin-coated sand may be stored for several months.

The combination of sand and resins for making molds—from metal patterns—has been in use through the postwar period. A major problem of mixing dry sand and resin was the fact that they tend to segregate when placed on a mold pattern or blown into a pattern or mold core box. Resin-coated sands are more homogeneous than a mix of dry sand and resin. In application at a foundry, they provide faster production, dust-free operation, more uniform structure, lower cost, minimum mold lubrication, and in many cases improved finish for the casting.

Union Carbide—Visking

Union Carbide Corp. has received the initial decision by the Hearing Examiner in the proceeding brought by the Federal Trade Commission to compel the corporation to divest itself of the assets acquired from The Visking Corp. in 1956. This decision would require Union Carbide to divest itself of that part of the assets used in polyethylene film production. The Examiner's decision will be appealed immediately to the full Federal Trade Commission. In the meantime, Union Carbide will continue to conduct business in the normal fashion. The decision does not require divestiture of the assets used in the manufacture of sausage casings.

Asbestos fillers

Two new Asbestos Float Grades, designated 7RF-9 and 7TF-8, for use as reinforcing fillers in plastics, have been announced by Carey-Canadian Mines Ltd., Cincinnati, Ohio. Since the beginning of the plastics industry, Canadian Chrysotile Asbestos has been used as a reinforcing filler. Besides reinforcing, Chrysotile Asbestos provides functions such as reducing molding costs, controlling flow, increasing hardness, decreasing molded shrinkage, improving mechanical properties, increasing heat and fire resistance, and facilitating ejection from the mold.

The new asbestos fillers are fine, short fiber grades prepared and graded from material taken from the air filtration system in the asbestos mill. Grade 7RF-9 is a highly fibrous, low-density, light-colored, grit-free, low magnetic iron-content Float. Tests have shown that this grit-free Float reduces wear on highly polished mold surfaces considerably, according to the company. Grade 7TF-8 is a high-density, light-colored, low resin-absorption Float. Because of low specific gravity, compounds using 7TF-8 Floats can be heavily filled.

Epoxy coating

A new 100% solids, single-component epoxy coating for continuous operation up to 155° C. has been announced by Columbia Technical Corp., Woodside, N. Y. Designated Type 1F56, the product requires no hardener and is cured by a short high-temperature bake. Shelf life is reportedly one year.

Pilot extruder for PE films

A pilot extruder for applying various types and thicknesses of polyethylene film (up to 12 in. wide and in small lot quantities) to a wide range of substrates has been installed by American Sisalkraft Co., Attleboro, Mass. The intention is to develop new custom-made wrapping combinations that then can be tested under simulated field conditions. According to the company, coatings as thin as ½ mil and as thick as 5 mils have been applied successfully to board stock, reinforced kraft paper, etc. Even burlap has been used experimentally as a carrier and laminated with a 5-mil film of polyethylene.

Plasticizer-stabilizer

Availability of a new low-temperature plasticizer for polyvinyl chloride has been announced by Rohm & Haas Co., Philadelphia, Pa. Named Monoplex S-74, it is a monomeric epoxy ester specifically developed to provide decreased volatility while maintaining good low-temperature flexibility and the ability to impart heat and light stability to polyvinyl chloride. Resistance to extraction by soapy water is also said to be substantially improved. The low viscosity and light color of Monoplex S-74 simplifies formulation and processing of PVC compounds, the company claims.

Filled nylon piston rings

Filled nylon is now being used to fabricate piston wear rings for use in heavy hydraulic cylinder applications for off-the-road equipment. The

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This new *low-cost* Dake Resin Mixer provides a perfect, uniform mix at all times. The specially designed disc blade shears in, mixing resin solids rapidly with a bottom-to-top blending action which minimizes heat buildup and lessens *kick-over* hazards. In addition, the mixer is completely self-contained and self-supporting, and the counterbalanced motor can be cranked up or down for loading.

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PAGE 179

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(*From page 208*)

material is said to have excellent wear resistance, requires no lubrication, and is used as bearings in many applications. It has a wide temperature range, remaining serviceable up to 350° F., has a low coefficient of friction, and will not gall cylinder walls on long stroke pistons where canted reciprocation may be encountered. The new wear rings are a product of Garlock Inc., Palmyra, N. Y., and are available in a wide range of standard sizes.

Solution-coated polyethylene

Demand for solution-coated polyethylene has thus far exceeded original estimates, states Kenneth J. Rawson, general sales manager of Plastic Papers Inc., Hicksville, N. Y. The Contour Coating process, exclusive with Plastic Papers, provides a uniform coating on both "hills" and "valley," according to Mr. Rawson.

The company's "different" coating machine coats polyethylene resins of various densities onto a variety of substrates, including pouch and kraft papers, paper boards, and foil-paper combinations. These coatings, said to be pin-hole free, are bonded firmly to the substrate material and are used in the heat-seal pouch industry (sugar, cereals), multi-wall, bed-pad, folding carton, and many industries requiring low-cost moisture- and grease-resistant barrier coatings. Plastic Papers claims it is impossible to delaminate the plastic film from the substrate by mechanical means. This coating is not to be confused with hot-melt coatings, emphasized Stanley P. Warshaw, president. Mr. Warshaw also stated that electrostatic treating equipment is on order which will make solution coated PE glueable with standard paper adhesives. This will allow the bag or box maker to convert Plastic Papers' Contour Coating without changing to special adhesives. Also, equipment is being installed to laminate two plies of paper with polyethylene. This will eliminate pasting problems in those areas where use of a sandwich sheet is practical.

Glass company enters foam field

Pittsburgh Corning Corp., a company whose business has been built on products of glass—glass block and cellular glass insulation—has entered the rapidly-growing foamed plastic field with a new polyurethane foam. The company is now producing rigid slabs of the foam, known as Foamthane, for a variety of thermal insu-

lating applications. This is the firm's first venture with a non-glass product, according to Russell Brittingham, president, and a step toward diversification. He said his company recognized the potential of foamed plastics for thermal insulation, a field in which PC is well established, and research indicated that polyurethane foam, although still comparatively new, was superior to other foamed plastics in many ways.

Fluorocarbons

Etching solution. A prepared etching solution for making fluorocarbon polymers bondable to other materials has been developed by Acton Laboratories, 1180 Raymond Blvd., Newark, N. J., under the designation Fluoroetch. An activated form of sodium in solution, the liquid reacts with the fluorocarbon resin, extracting fluorine atoms at the surface with the formation of a carbonaceous film which is compatible with most adhesives. One pint of solution will effectively etch 50 to 60 sq. ft. of polymer surface. If the solution is exposed to air, it will lose its activity in about 1 hr., depending on the amount of surface area exposed to the atmosphere. The active blue-black product changes to a brown inactive material.

Acton Fluoroetch solution is available in pints; quarts; and 1-, 5-, and 55-gal. drums.

Another material for preparing Teflon, TFE, FEP, and Kel-F surfaces for bonding to other materials has been put on the market by W. S. Shamban & Co., Culver City, Calif. Named Bondaid, the compound is said to be applied easily, safely, and effectively in the field without elaborate equipment, and can be applied to an entire piece or to a limited area. Bondaid can be color dyed for identification of a fluorocarbon.

Oriented sheet. Teflon sheet which is placed in hydraulic coining presses to further compact the material, as an added step following the customary sintering process, is being produced and distributed nationally by Cadillac Plastic & Chemical Co., Detroit, Mich. This orienting process is said to improve Teflon for gasket applications by minimizing the need to retighten flange bolts and fasteners. Cadco Teflon is available in thicknesses from $\frac{1}{32}$ to 2 in., and in sizes up to 48 by 48 inches.

Spray. A fluorocarbon slip and antistick agent, called Rulon Spray, has been introduced by Dixon Corp., Bristol, R. I., processor and fabricator

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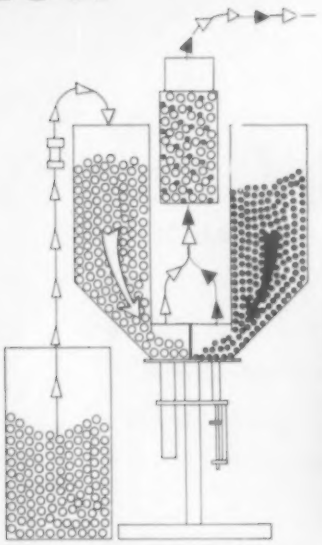

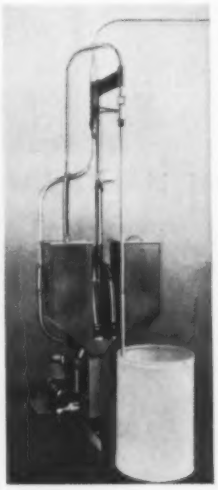

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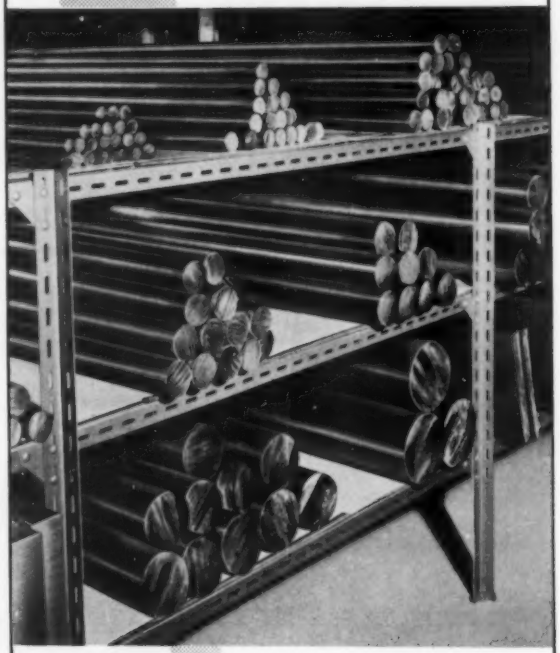

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(*From page 211*)

of fluorocarbon products. Available in 6-oz. aerosol cans at $2.50 each, the spray is designed as a lubricant for belts, packings, gears, metal-cutting, etc., and as an anti-stick agent for blenders, chutes, conveyors, etc. It is said to provide a low-friction, dry film, which is chemically inert, insoluble, and thermally stable to over 500° F.

Coating with FEP resin. Fluidized-bed coating with Teflon 100 FEP fluorocarbon resin shows promise for protecting pump impellers, valves, rotors, and other motor hardware, filter plates, pump-heads, ball bearings, and other irregularly shaped mechanical components against corrosion, according to Du Pont. During actual coating procedures, the part being clad is oven-heated to provide a surface temperature of about 650° F. for dipping into the fluidized bed. After a 1- to 2-sec. dip in the fluidized bed, followed by low-pressure air blasting to remove excess powder, a return trip to the oven for 20 min. of additional heating fuses the adhering particles of Teflon FEP resin into a continuous 2-mil film. Because 8 mils are considered to be the minimum film thickness for adequate corrosion resistance, additional dips are made. Each subsequent dip picks up about 1½ to 2½ mils of film, Du Pont says. For such a coating technique, maximum permissible coating thickness is roughly 15 to 17 mils. Above this thickness, the film tends to blister and sag.

High-temperature laminate. A new laminate said to be highly resistant to chemical attack, to have excellent electrical properties, outstanding resistance to mechanical abuse and low flow under heat and pressure has been announced by Mica Insulator, a division of Minnesota Mining & Mfg. Co., Schenectady, N. Y. Called No. 6098 Lamicoid, it is manufactured from Teflon resin and a fine weave glass fabric. Because of the fine weave of the glass used, the Teflon resin is evenly distributed throughout the laminate insuring very uniform electrical and physical properties, including thickness and surface finish, it is stated. In addition, company engineers have reportedly perfected techniques and adhesives that make it possible to bond 1- or 2-oz. copper foil to one or both sides of this laminate. These laminates, called CuClad Lamicoid No. 6098, are suggested for high-temperature (200°

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FACTS: Technical Bulletin PL-409 gives complete performance data—including specific details on how SANTICIZER 409 can help you make:

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- **migration-resistant, low-odor refrigerator gasketing.**

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West Germany

(*From page 213*)

C.) printed circuits and also microwave applications. The new laminate is made in standard 17- by 37-in. sheets in thicknesses from 0.006-in. to 0.250-inch. Prices range from $25.65 per sheet at 0.006-in. to $241.62 per ¼-in. thick.

Teflon-covered roll. A relatively thick Teflon covering for steel, aluminum, and bronze rolls has been developed by Manhattan Rubber Div. of Raybestos-Manhattan Inc., Passaic, N. J. The problems associated with sprayed-on Teflon, such as peeling and rapid wear, are said to be eliminated by using the new covers. Manhattan Teflon roll covers can be reground, if necessary.

Applications for the rolls are anticipated in textiles, for coating and size drums, and gluing rolls in the printing industry, in paper manufacturing and sheet plastics production. Facilities are presently available to provide coatings up to 0.030 in. on rolls up to 4 ft. in diameter with a maximum overall length of 15 feet. Greater thicknesses and larger rolls can be handled by the company on a custom basis.

New molding composition from Teflon. Production of a new molding powder of Du Pont's Teflon 100-FEP resin compounded with 10 or 20% fibrous glass has been announced by Crane Packing Co., Morton Grove, Ill. Similar to Teflon-TFE, Teflon 100 has been primarily developed for injection molding. The properties of Teflon 100-FEP are considerably enhanced for many applications through the addition of a filler. It is stiffer, has a smaller shrinkage factor (up to 50%) in molding operations, and has better wear resistance than the unfilled Teflon 100. Typical applications include coil forms and bobbins, tube sockets, and connector assemblies.

Electroplated Teflon. A process for plating metals directly on Teflon has been developed by Plasitron Inc., New York, N. Y. The process permits the use of the entire range of electroformable metals, both base and noble, on an unlimited variety of Teflon shapes. Tests performed by York Research Corp., an independent testing laboratory, show that the new process provides complete adhesion with no loss of Teflon's electrical properties, and even permits soft-soldering without damage. According to the company, successful applications of the process have already been made in

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Epoxy resins modified with MOD-EPOX for better flow and lower cost show better dimensional stability—lower power factor—equivalent hardness—and higher adhesive strength (*shear bond strength of a standard epoxy adhesive increases more than 50%, steel-to-steel*).

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FACTS: Technical Bulletin PL-313 gives complete performance data—including specific details on how MOD-EPOX can help you make:

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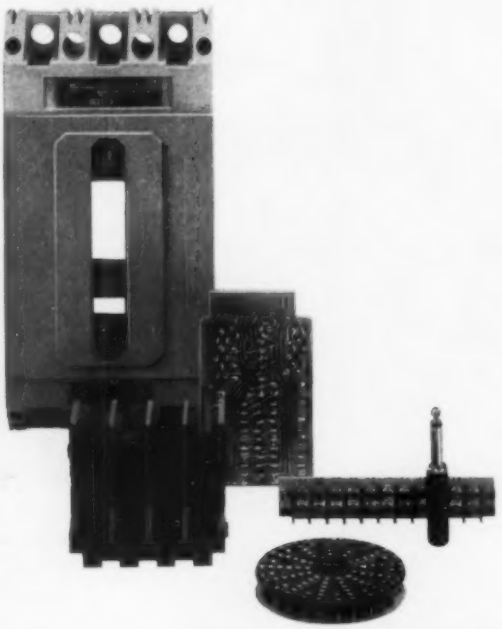

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THE PLASTISCOPE

(*From page 215*)

dielectric wave guides, feed-through insulators, and flush antennas for missile use that are said to completely eliminate the need for radomes.

Foams

Vinyl foam process licensed. Vitapol Ltd., a subsidiary of Vitafoam Ltd., Manchester, England, has been licensed by the Girdler Process Equipment Div. of Chemetron Corp. to make vinyl (PVC) foam by the Elastomer process. This brings to 13 the number of companies in 10 overseas countries licensed to produce PVC foam by the Elastomer process. The Vitapol product, manufactured in slabs up to 6 ft. wide and 4 in. thick, will be used initially for welded trim, overhead liners, and interior paneling for the automotive industry. For such applications, the vinyl foam will be cut into slices only 5/32 in. thick.

Polyglycols. The addition of polyglycols, major components of urethane foam, to the Vibrathane products group of Naugatuck Chemical Div. of U. S. Rubber Co., has further expanded the company's line of raw materials supplied to the growing urethane industry. Vibrathane products include diisocyanates, casting resins, gums, chemical additives, and similar products.

Pipe insulation. An all-purpose industrial urethane foam pipe insulation, called Thermax, is being produced by American Cellular Co. Inc., New Castle, Del., using a foam system supplied by Isocyanate Products Inc., also of New Castle. Thermax is reportedly designed to insulate any pipe from —300 to 275° F., and is constructed with a longitudinal seam which allows it to be spread open to receive the pipe and, upon release, to snap quickly into the designated position. Basic chemicals for the foam are supplied by Mobay Chemical Co.

Unarco U-200, a preformed self-extinguishing urethane foam made by the Fibrous Products Div., Union Asbestos & Rubber Co., Bloomington, Ill., from prepolymers produced by John H. Witte & Sons' Resin Div., Burlington, Iowa, is now being used to insulate low-temperature piping and equipment. The rigid foam comes in 36-in.-long half-round sections in standard pipe and tubing sizes. The product is also available in blocks 12 by 36 inches. Temperature limits for

How SANTICIZER® 160 speeds processing and cuts costs of nonstaining PVC film and sheeting

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THE PLASTISCOPE

(*From page 217*)

Unarco U-200 are from —300 to 220° F.

Commercial availability of a new intermediate for polyether (urethane) foams, called Niax hexol LS-485, has been announced by Union Carbide Chemicals Co. The product, a derivative of propylene oxide, is said to have low molecular weight (about 700) and high functionality, which provide increased crosslinking density in rigid foams. It is also suggested as an intermediate for various resins, adhesives, plasticizers, etc.

Urethane foam for RR tank cars. Tests to determine the performance of rigid urethane foam as a protective insulating jacket on railroad tank cars are being conducted by Allied Chemical Corp. The urethane jacket is expected to withstand the flexing and jolts of normal tank car service, provide better insulation, be easier to repair in case of a wreck, and reduce painting maintenance.

During the evaluation work, a 4-in.-thick jacket of rigid urethane foam was sprayed on the tank shells of two of Allied's 4000-gal. railroad tank cars, and a 40-mil-thick light gray coat of catalyzed polyester reinforced with chopped glass fiber roving was sprayed on for vapor sealing and decorative purposes. About 575 lb. of 2½-lb./cu.-ft. density rigid urethane foam were used per car. The tank cars will carry urea-formaldehyde fertilizer solutions at about 77° F.

The insulation and steel outer jacket combination now used on railroad tank cars weighs about 6 lb./sq. ft., while the urethane foam jacket weighs 1 lb./sq. ft., according to James Egan, manager of the railroad equipment for Allied's Traffic Dept.

A big advantage of the urethane foam jacket is that it could be easily repaired by spraying in case of a wreck. The foam jackets also eliminate rust and corrosion problems.

Insulating Applicators Inc., New Lenox, Ill., did the actual spray application of the urethane foam jackets. The self-extinguishing foam was produced from urethane prepolymers that are manufactured by John H. Witte & Sons, Resin Division, Burlington, Iowa.

New companies

Oxo Chemicals Co., Chicago, Ill., a newly formed company jointly owned by **Pittsburgh Chemical Co.,** Pittsburgh, Pa., and **Amoco Chemicals Corp.,** Chicago, plans to construct a multimillion lb./yr. isooctyl and decyl alcohol plant at Haverhill, Ohio. Completion is scheduled for early 1962.

Isooctyl and decyl alcohols are used, among other applications, to make plasticizers for vinyl resins. **Jay H. Forrester,** president of Amoco Chemicals Corp., is also president of Oxo Chemicals Co.

Synthetic Polymers, Whiting, Ind., has been formed by **Aubrey R. McKinney,** formerly senior research scientist with Standard Oil Co. (Indiana). The new company will offer design, development, and consultative services in the fields of petrochemicals, plastics, fibers, and related processes, with special emphasis on the synthesis of raw materials and polymerization processes in the manufacture of synthetic polymers.

Taylor Custom Compounding Co., Erie, Pa., has been established by **J. Carter Taylor** to service molders and extruders in compounding and reprocessing of polyethylene, polypropylene, acetate, butyrate, methacrylate, vinyl, and styrene resins. The new company will not buy or sell material. It will work with the customers' materials, instead, converting them to numerous specified colors and compounds.

Hallmark Synthetics Corp., New York, N. Y., has been formed for the converting and jobbing of vinyl film. **Norman L. Flewwell'n** is president. The new company also has plans underway to import a line of unusual vinyl finishes.

Expansion

Koppers Co. Inc. has completed a new warehouse building at its Durethene polyethylene film plant in Chicago, Ill., which adds 20,000 sq. ft. to existing storage space and makes it possible to stock enough of the film to ship out orders the day after they are received at the plant.

Nopco Chemical Co. is constructing a $7 million isocyanate plant on a 9-acre site in the Tremley Point section of Linden, N. J. Scheduled for completion by the end of 1961, and for production by early 1962, the new plant will make principally toluene diisocyanate, a basic ingredient for the urethane foams produced by the company's Plastics Div. The plant will make Nopco the only producer of urethane foam with a fully integrated operation supplying its own isocyanates. **H. W. Boynton,** project

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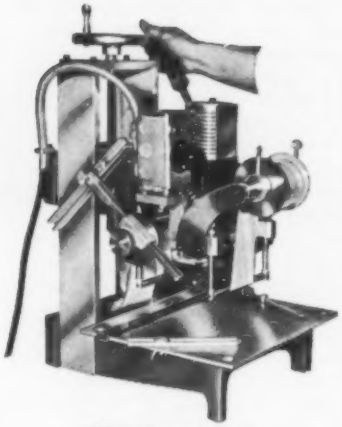

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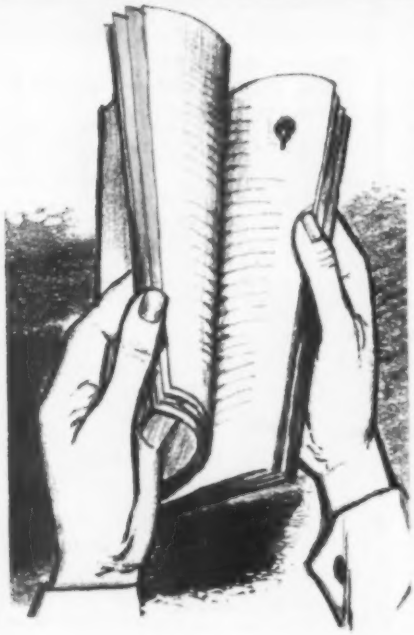

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THE PLASTISCOPE

(From page 219)

manager, has announced that the plant will have a design capacity of 10 million lb./yr. and will be expandable to 20 million.

In addition to the new TDI plant, Nopco has recently added 25% additional capacity to its main Plastics Div. plant at North Arlington, N. J., and a new foaming and fabricating facility is nearing completion at Chattanooga, Tenn.

Solar Chemical Corp., Leominster, Mass., has announced a $5 million expansion program involving new products, new construction and research. Solar Chemical Corp. has grown to a multi-million dollar producer of crystal and high-impact polystyrene in seven years.

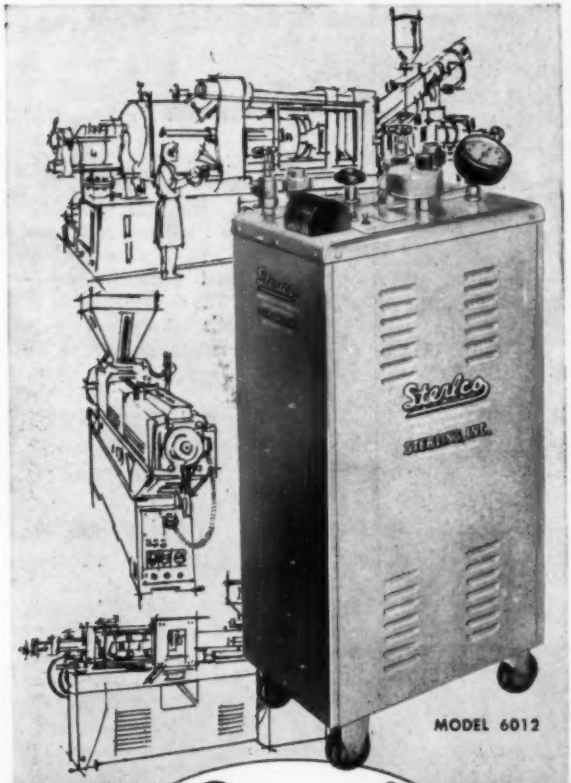
Mirra-Cote Co., El Segundo, Calif., has purchased the assets of **Arrow Plastic Molders Inc.,** Inglewood, Calif. Plant and warehouse have been expanded in El Segundo, whereby all equipment of both companies can be integrated in the Mirra-Cote location to provide complete facilities for design, tooling, injection molding, plating, and decorating of plastic parts. Mirra-Cote does vacuum metallizing on plastic, produces electronic and missile applications, product identification, point of purchase signs, and vacuum metallized nylon bathroom fixtures. The firm is 10 years old.

Heyden Newport Chemical Corp. is constructing a new fumaric acid plant at Garfield, N. J., expected to go on stream in the second quarter of 1961. Heyden Newport recently obtained from **Scientific Design Co. Inc.** the rights to a process to produce fumaric acid which is being used in the fumaric acid plant.

Heyden Newport has now placed two new plants on stream since Nov. 1960, and four more are due for completion soon with one of them destined to be a 24-million-lb./yr. maleic anhydride plant.

Rezolin Inc. has moved to a new 7500-sq.-ft. plant at 35640 S. Gratiot Ave., Mt. Clemens, Mich., a suburb of Detroit. The company specializes in formulated plastic compounds for plastic tooling, electrical insulation, adhesives, and specialty compounds for the building industry.

Dominion Tar & Chemical Co. Ltd. has approved plans for building a new 22-million-lb./yr. phthalic anhydride plant adjacent to its present facilities



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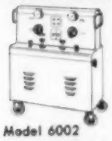
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THE PLASTISCOPE

(From page 220)

in Toronto, Canada. The plant, to cost approximately $3.5 million, will be engineered and constructed by **Canadian Badger Co. Ltd.,** Toronto. Dominion Tar & Chemical's new plant will use the fluid bed process, which permits lower operating costs, gives higher yields, and produces a higher grade product. The project is the sixth fluid bed phthalic anhydride contract awarded to Canadian Badger Co. Ltd. since 1958, and will be the first of its type in Canada.

When the new plant is completed early in 1962, it will bring Dominion Tar's phthalic anhydride capacity up to 35 million lb./yr.

Chemplast Inc., East Newark, N. J., has doubled its plant space in an expansion move to fill customer requirement for machined shapes of the company's processed TFE fluorocarbon resins (Teflon).

Chemplast Inc. started six years ago to produce a variety of Teflon products, which include laboratory ware, molded sheets, molded and extruded rods, tubing, and special shapes —slip-on spaghetti tubing, Teflon tape, and dry film lubricant, packaged as an aerosol.

Acme Resin Corp. has completed new general office quarters at Forest Park, Ill. The previously used office space has been added to Research Department facilities.

Acme Resin Corp. claims to be the first commercial source of diallyl phthalate molding compounds and the originators of liquid phenolic resins for coating foundry shell molding sands. The completed building program also included substantial additions to the space for manufacture of these products and other liquid phenolics and urea furfuryl resins.

The **Ohio Oil Co.** and **The Dow Chemical Co.** have announced a long-term agreement to provide the chemical firm with about 20 million gal. of benzene-toluene mixture annually, starting in mid-1962. The key facility involved will be the Detroit refinery of **Aurora Gasoline Co.,** a wholly-owned subsidiary of Ohio Oil, which is being expanded.

Dow will build a processing unit at its petrochemicals plant at Bay City, Mich., to convert the benzene-toluene mixture to benzene for use as a raw material in its Bay City and Midland chemical plants.

Ohio Oil officials pointed out that since pure benzene will freeze solid

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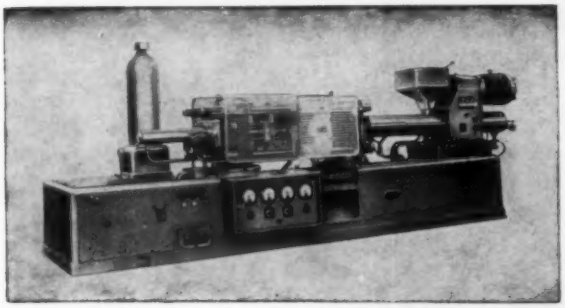

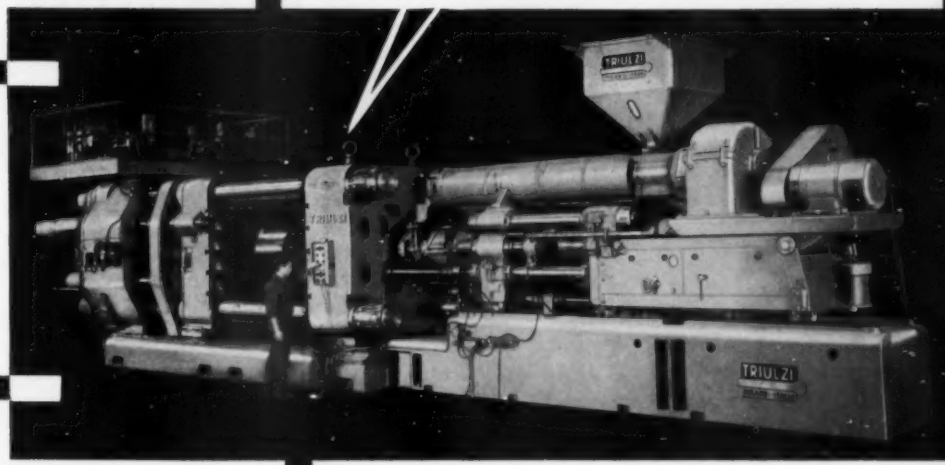

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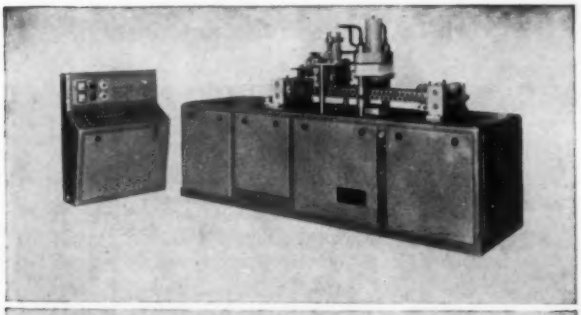

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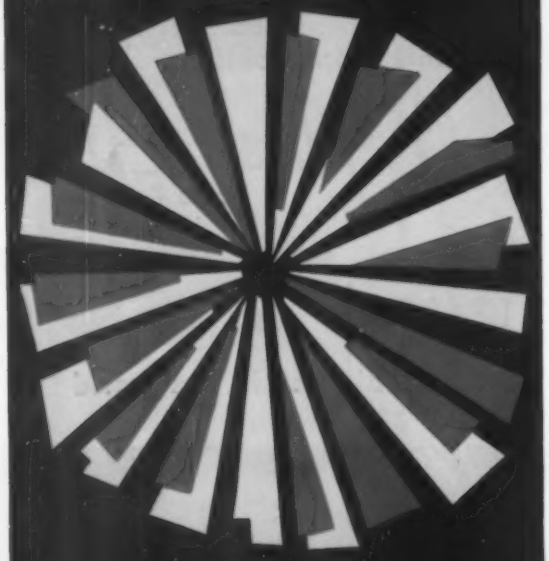

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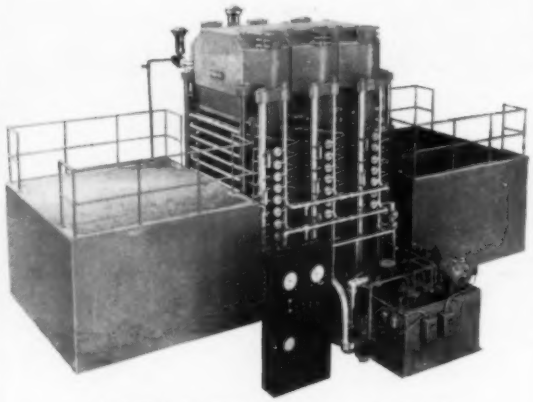

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THE PLASTISCOPE

(From page 222)

at about 40° F., the year-round pipe line delivery problem will be overcome by the benzene-toluene mixture, which stays liquid in temperatures as low as 50° below zero.

Armstrong Resins Inc. has acquired all the assets of **Tylene Plastics Inc.,** and has moved all of the Tylene inventories, records, laboratory and production facilities, along with key personnel from Michigan City, Ind., to its main office and plant located in Warsaw, Ind. From now on, the new acquisition will be known as **Tylene Plastics Co., Div. of Armstrong Resins Inc.,** Warsaw, Ind.

Molded Fiber Glass Companies has completed a program to double capacity of its polyester resin plant at Ashtabula, Ohio. The plant addition was designed specifically for production of isophthalic-based resins with optimum resin stability and improved color. The original plant went into production in Dec. 1959 with a capacity of 5 million lb. a year.

Glaskyd Inc. has opened a new 13,000-sq.-ft. plant on a 20-acre site in Perrysburg, Ohio, 12 miles southwest of Toledo. Glaskyd is a producer of glass reinforced alkyd molding compounds and was founded in 1950. During the first year of operation, alkyd molding compounds in continuous rope form were developed and patented by the company.

Canford Mfg. Corp., Canton, Pa. custom molder, has purchased the machinery, tools, and equipment of **Klear Plastics Inc.,** Quakertown, Pa. The business will continue at its present location as the **Klear Plastics Div.** of **Canford Mfg. Corp.** Klear makes plastic lids for the food industry.

Canford Mfg. Corp., a wholly-owned subsidiary of **Stanley Home Products Inc.,** Westfield, Mass., began operation last year.

Thermotech Industries Inc. is the new parent firm name of the recently merged **Booker & Wallestad Inc.,** St. Louis Park, Minn., and **Thermotech Plastics Inc.,** Hopkins, Minn. Booker & Wallestad, started in 1953, and the subsidiary Thermotech Plastics, formed in 1957, will continue to do business under their separate names as divisions of the new parent firm. Officers are **Eugene M. Booker,** president; **Victor C. Wallestad,** vice-president and secretary; and **Robert G. Booker,** vice-president and treasurer. Together the two divisions of Thermotech Industries employ about 125 persons. Booker & Wallestad division of the company carries on the basic business of designing and engineering services and tooling and molding of thermoplastic compounds. The Thermotech Plastics division offers similar services but is also involved in molding thermosetting compounds.

Coming events

Plastics groups

April 26-28: The Society of the Plastics Industry (S.P.I.), 18th Annual Western Section Conference, Hotel del Coronado, Coronado, Calif.

May 8, 9: S.P.I. 19th Annual Canadian Section Conference, Sheraton-Brock Hotel, Niagara Falls, Ont., Canada.

June 5-9: S.P.I. 9th National Plastics Exposition and National Plastics Conference, Coliseum and Commodore Hotel, New York.

June 16-25: Europlastica 1961, Palais des Floralies—Parc, Ghent, Belgium. Contact: H. P. Persin, Sec. General, at above address.

June 21-July 1: Interplas 61, 6th International Plastics Exhibition and Convention, Olympia, London, England. Contact: John L. Wood, Dorset House, Stamford St., London SE 1, England.

Sept. 22-Oct. 1: International Plastics Fair, Copenhagen, Denmark. Contact: Int. Plastics Fair Secretariat, 10 Puggaardsgade, Copenhagen.

Oct. 17-19: The Plastics Show of Canada, Canadian National Exposition, Toronto. Contact: W. B. Pryde, Show Manager, 481 University Ave., Toronto, Canada.

Other groups

May 16-18: Building Research Institute Spring Conferences, Shoreham Hotel, Washington, D. C.

May 17, 18: Chemical Market Research Assn., 21st Annual Meeting, Plaza Hotel, New York, N. Y.

May 22-25: Design Engineering Show and Conference, Cobo Hall, Detroit, Mich.

June 9-17: ACHEMA 13th International Chemical Engineering Exposition and Congress, Frankfurt am Main, Germany.

Sept. 5-8: 11th National Chemical Exposition, sponsored by Chicago Section, American Chemical Society. International Amphitheatre, Chicago, Ill.—**End**

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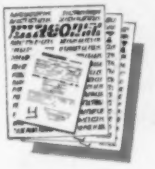

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COMPANIES...PEOPLE

Appointments, promotions, and relocations in the plastics industry.

Union Carbide Plastics Co.: Howard L. Burpo Jr. appointed regional mgr., Midwestern sales region, with headquarters in Chicago, Ill. **P. W. Wood,** formerly Midwestern regional mgr., named product mgr., polyethylene, with headquarters in New York gen. sales office.

Allied Chemical Corp.—Plastics Div.: new dist. sales mgr. appointments are: **James P. Barry,** Cleveland, Ohio; **Martin H. Styles,** Philadelphia, Pa.; and **C. Burton Wing,** Boston, Mass.

Advanced Products Co. Inc., Toledo, Ohio, has become a wholly-owned subsidiary of **Unitcast Corp.,** and will operate under the name of **Unit-Plastics Inc.,** Liberty Center, Ohio, to continue manufacture of reinforced plastics molded parts. **Joseph L. Tillman III,** v-p of Unitcast, named pres. of the new firm. **Roger C. Schmidt,** who with his brother, **Gerald,** founded Advanced Products in 1950, will serve as the sales mgr. and gen. supt.

General Electric Co., Laminated Products Dept., Coshocton, Ohio, has established a South Atlantic dist. sales office in Greensboro, N. C., for its Textolite industrial laminates. **Lou A. Merritt** appointed sales engineer for industrial plastic laminate insulating materials.

Vulcanized Rubber and Plastics Co. has reorganized and consolidated all exec., gen., and div. sales offices, formerly located in New York City, in Morrisville, Pa., and will now operate directly from the plant. **Alfred O. Redland** is pres. and gen. mgr.; **Vincent L. Mears** is supt. of the Plastics Div.

Escambia Chemical Corp.: J. M. Martin appointed sales mgr., vinyl resins, with headquarters in New York City; **J. T. Carley,** sales rep., vinyl resins, for New England and metropolitan New York; and **Lois Follansbee,** sales correspondent for vinyl resin and industrial chemicals in the company's N. Y. gen. offices.

The Rainville Co., New York, N. Y. mfr. of plastics machinery and equipment, has established a Mexico City, Mexico dist. office headed by **David L. Enequist.**

The Goodyear Tire & Rubber Co.—Films & Flooring Div.: P. E. Mulvehill transferred from Cleveland, Ohio to Los Angeles, Calif. as Western dist. mgr. He replaces **J. B. Post,** who was reassigned as packaging film rep. in Los Angeles. **E. F. Latta,** of the Akron sales staff, promoted to North Central dist. mgr., succeeding Mr. Mulvehill.

Plastocon Corp. is the new corporate name of **Economy Precision Products Corp.** The company has recently moved from Germantown, Wis., to new, larger facilities in Oconomowoc, Wis. The company specializes in product design as well as custom injection molding.

Fenwal Inc., Ashland, Mass., has formed a new division for manufacture of epoxy resin formulations and a complete line of epoxy packaging and dispensing systems.

A. L. Hyde Co., Grenloch, N. J.: **Harry Kleinfelder** appointed sales mgr., Custom Molding Div.; **Frederick Wieland** named sales mgr., Rod and Slab Div.

Air Reduction Chemical & Carbide Co., div. of Air Reduction Co. Inc.: Gordon E. Cole named gen. sales mgr., organic chemicals dept. and Colton polymers dept. **James K. Ames** appointed sales mgr., Colton polymers dept. **Charles O. Herman** named mgr., new products dept. **Harold L. Jaffe** is div. tech. mgr.

Chemical Process Co., San Francisco, Calif.: **H. H. Pomeroy** appointed v-p and mgr., Plastics Div. **D. S. Catterson,** v-p and mgr., Adhesives Div.; **George F. Stoneman,** v-p and mgr., Ion Exchange Div.

Kautex Machines Inc. has been established in Linden, N. J., as U. S. sales organization for **Kautex-Werke Reinold Hagen,** West Germany, and carries a full supply of spare parts for use on the parent company's blow molding machines.

Koppers Co., Pittsburgh, Pa.: **J. B. Schmitt** named production mgr., Durethene film operations of the Plastics Div. **John J. Guth** promoted to plant supt. of the company's Los Angeles, Calif. Durethene film plant.

Hysol Corp., Olean, N. Y. mfr. of epoxy tooling materials: **William I. Childs** and **Jimmy W. Hill** joined the research and development staff.

Hobbs Mfg. Co., Worcester, Mass. mfr. of winding and cutting equipment and die presses: **E. Clayton Van Stavern** appointed sales engineer, Northeast sales area. **Robert P. Simoncini** named asst. sales mgr., Machine Div.

Sealomatic Electronics Corp., Brooklyn, N. Y. mfr. of electronic heat-sealers and blister-packagers, has established an office and showroom at 38 W. 32 St., New York, N. Y. Heading the sales staff are **Ernest Gross,** v-p, and **Ivan Goldberg,** who will serve as sales mgr.

James E. Rogers appointed tech. service mgr. of **Moxness Products Inc.,** Racine, Wis. subsidiary of **Plastics Corp. of America Inc.** Moxness Products is a manufacturer of silicone and fluorocarbon products for electrical insulation.

C. A. Bergman appointed market mgr., chemicals, **General Dyestuff Co., div. of General Aniline & Film Corp.,** New York, N. Y. He has been with the company for 24 years.

Henry P. Trounstine, gen. mgr. extruded products div., named a v-p of **Clopay Corp.,** Cincinnati, Ohio producer of extruded vinyl and polyethylene film.

R. B. Baptie appointed sales mgr. of the **Carwin Co.,** N. Haven, Conn. producer of organic chemicals, isocyanates, and urethane foam systems.

James P. Brouder named sales mgr. of **Nu-Dell Plastics Corp.,** Chicago, Ill. producer of injection-molded housewares and specialty items.

George Beetlestone, formerly dir. R & D, promoted to plant supt. at **The Fluorocarbon Co.,** Anaheim, Calif. processor and fabricator of fluorocarbon products.

Charles C. Thacker Jr. named mgr. of laboratories, Plastics Div. of **Nopco Chemical Co.** The div. has underway a new urethane foaming plant at Chattanooga, Tenn., and construction has begun on a new multi-million-dollar plant in Linden, N. J. to produce toluene diisocyanate, a basic ingredient that is used in making urethane foam.

Neil Huizing, plastics molding specialist, joined sales-engineering staff of **F. J. Stokes Corp., Press Div.** He will headquarter at the Div.'s dist. office in Union, N. J.

Lawson Wilder appointed mgr. of sales service for **Ludlow Plastics, div. of Ludlow Corp.,** Needham Heights, Mass., with headquarters at the Homer, La. plant.

Omission

"Mammoth blow molding" (MPI, Feb. 1961, p. 87): The aluminum blow-mold for this toy racing car was fabricated by Springfield Cast Products Inc., 124 Switzer Ave., Springfield 9, Mass.—**End**

IMS Bolted Vented Reverse Flow

DEGASSING

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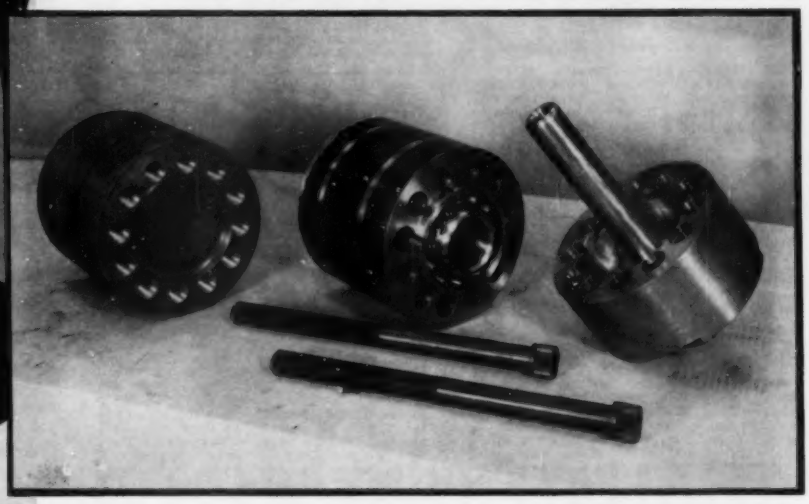

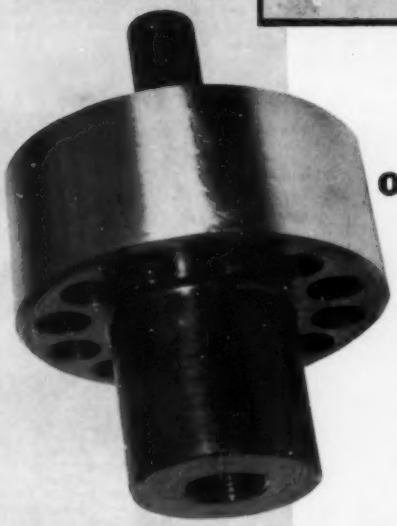

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MACHINERY FOR SALE—MPM Pelletizer, Model F-52 3 HP. Ball & Jewell Portable Rotary Cutter M-100 3 HP. Ball & Jewell Rotary Cutter 1½"—20 HP. Moslo Mixer and loading conveyor 3000# capacity. NRM Extruder 1" Bench Model ¾ HP. Van Dorn Injection Press—1 ounce. Platform Scales, Dial and Beam Factory Trucks. Air Compressors—1½ and 2 HP. Reply Box 6877, Modern Plastics.

MOST MODERN PACKAGING AND PROCESSING MACHINERY Available at great savings. Baker Perkins, W. & P. and Day Double Arm Steam Jacketed Heavy Duty Mixers—25, 50, 75, 100, 150 and 200 gal. capacities. Day, Robinson 50 to 10,000 lbs. Dry Powder Mixers, Jacketed and Unjacketed. Also wood and enamel. H. K. Porter 650 gal. Steam Jacketed Double Spiral mixers. B. P. 100 gal. Jacketed Stationary Vacuum Double Arm Mixer. Day Imperial 75 gal. Double Arm Mixer, Sigma, Dispersion Blades. Mikro Pulverizers, Models Bantam, 1SH, 2TH, 3TH and 4TH. Fitzpatrick Models D, K-7 and K-8 Stainless Steel Comminuters. Colton 2RP, 3RP, 3B, 5½ T Tablet Machines. Stainless Steel Jacketed Mixing Kettles 100 and 150 gal. capacities. Day Ro-Ball Sifters. Package machinery, Hayssen, Scandia, Wrap King, Campbell, Miller Wrappers. Cartoning machines—Ceco, Pneumatic Scale, Jones. Filling machines—all types and sizes. Union Standard Equipment Company, 318 Lafayette Street, New York 12, N.Y. Phone: CAnal 6-5333.

FOR SALE—Stokes Molding Presses 150 ton, 100 ton and 50 ton. Fully automatic. Some Transfers available. Stokes Model 294 Single Punch Tablet Press. Completely rebuilt with variable speed drive. Injection molding machines—1 oz. Van Dorn, 1 oz. DeMattia, 8 oz. Reed Prentice, 12 oz. DeMattia, 16 oz. HPM, 24 oz. Watson Stillman and other sizes in stock. Ball & Jewell #1½ Rotary Scrap Grinder, Ball & Jewell #1½ Scrap Grinder. Cumberland and Foremost Grinders, from ½ HP to 5 HP. Transfer molding presses—300 Ton Stokes. Smaller sizes available also. Over 400 Compression Molding Presses in stock. Sizes up to 2000 ton. Many multi-opening. Liquidations our specialty. What do you have for sale? We will finance your purchases. Johnson Machinery Company, 90 Elizabeth Ave., Elizabeth, New Jersey. ELizabeth 5-2300.

FOR SALE—one Fellows 1952, 3 ounce injection molding machine, type 1B3-15, fully automatic, perfect working condition. Rex Industries, Inc., 32-27 Downing Street, Flushing 54, New York. INdependence 1-8300.

FOR SALE—4 oz. Crownmaster with pre-plasticizer; single ram 1¼" dia. Fully automatic. Purchased 1959. Excellent running condition. Make offer. Pacific Plastic Products, PLaza 6-9600, So. San Francisco, Calif.

FOR SALE—(2) Baldwin 100 ton self-contained transfer molding presses. (1) Stokes model 741 — 50 ton automatic molding press. (1) Hartig 2" electrically heated plastics extruder. (2) Dunning & Boschert 300 ton compression molding presses. (2) Bipel 35 ton preform presses. Chemical & Process Machinery Corp., 52 9th Street, Brooklyn 15, N.Y., HY 9-7200.

WHEELABRATOR PLASTIC DEFLASHERS for sale: 15x20 Tumblast, 27x36 Tumblast and No. 1 Multi-table complete with dust collectors, control panels, p.b. stations. Guaranteed to be in like-new condition. Ideal for deflashing of plastic parts. Universal Machinery & Equipment Co., 1630 N. 9th St., Reading, Pa. FRanklin 3-5103.

INJECTION MOLDING—HPM 9 oz; Hydraulic Press, French oil semiautomatic 100 ton; Elmes 60 ton high speed; Mill-Farrell 16x36; Baker Perkins SS, 2 arm, jacketed, vacuum, hydraulic tilt, 100 gal-50HP, also SS tank 11, 100 gal. Mixer 2 arm 150 gal. Day Imperial steel; Extruder 8" elec. heated; Ram extruder. Machinecraft Corp., 800 Wilson Ave., Newark 5, New Jersey. MI 2-7634.

YOUR BEST BUYS in guaranteed equipment. (6) Stokes 150 Ton Self Contained Molding Presses; Robas Press 24" Ram, 30" x 48"; 40 openings; (6) Southwark Presses 36" x 36", 14" Ram; HPM Self Contained Presses, 7 Ton and 25 Ton; Stokes #280 and Colton #5½ Preform Presses; S.B. 450 Ton Press, 36" x 36"; 22" Ram. Extruders: NRM 1½"; Royle 2"; Hydraul. Strainer 15". Rotary Cutters: Ball & Jewell #1 and #2; IMS Model MF and Sprout-Waldron 15 HP; New Falcon Double Ribbon Mixers; all sizes; Baker Perkins Heavy Duty Jacketed Mixers to 300 gal. F-B Unused 2 Roll Mills; 14" x 30"; late models. 2 Roll Calender 22" x 58" with accessories. Inquire about the FMC Rental-Purchase Plan. First Machinery Corp., 209-289 Tenth St., Bklyn. 15, N.Y. ST-8-4672.

FOR SALE—One 3 Roll Throp Calender 18" x 54". 20 H.P. variable speed D.C. motor. 125 H.P. M.G. Set. Controls. One Farrel-Birmingham 22" x 60" Mill. 125 H.P. motor. Reply Box 6866, Modern Plastics.

DUPLEX SLITTER — Unused — 57" wide, suitable for slitting rolls ⅝" or wider, any non-elastomeric plastic .001-.040 — finished diameter 10". Alternate rolls rewind on opposing shafts eliminating any interlocking. Price $1350. Reply Box 6864, Modern Plastics.

FOR SALE — (1) — Stokes G4 Preform Press; (1)—No. 3 Banbury Mixer 75 HP; (2)—Baker Perkins 50 and 100 gal. Sigma Blade Jacketed Mixers; (1)—No. 1 Ball & Jewell Rotary Cutter; (1)—No. 18 Cumberland Rotary Cutter; (3)—Mikro Pulverizers, Bantam, 1SH and 1SI; (6)—Stokes Preform Presses, models R, T, DD2, DDS2, DS3 and D4; partial listing, send for details. Brill Equipment Company, 35-55 Jabez St., Newark 5, N.J. Tel: Market 3-7420.

FOR SALE—Automatic Sentinel vacuum forming machine. Forms, slits, & cuts off the blister automatically. This includes a very fast heat sealing machine. Complete line available to blister pack your product. Contact W. Furiong, Helene Curtis Ind., 4401 W. North Ave., Chicago 31, Illinois.

FOR SALE—4300 gal. T304 stainless horiz. tank, ASME 30# WP; Sturtevant #59B stainless rotary blender; Baker-Perkins 200 gal. jacketed sigma-blade mixers; 200 gal. and 500 gal. stainless jacketed reactors; 1350 gal. T347 stainless jacketed resin kettle; American 42" x 120" dbl. drum dryer, ASME code, stainless trim; 2750 gal. T316 stainless pressure tanks, coils, dished heads; 1800 gal. T316SS jacketed and agit. resin kettle; 800 sq. ft. T316SS shell and tube heat exchangers; Baker-Perkins #15-UUMM, 100 gal. jktd. dispersion blade mixer, 100 HP; Worthington 70 cu. ft. rotary blender. We pay cash—top dollar—for idle, surplus equipment. Perry, 1429 N. 6th St., Phila. 22, Pa.

PLASTIC BLOW MOLDING MACHINES — Imported at sensational low prices. Large machine with three inch extruder, 2 stat, delivered N.Y. duty paid $4000.00, others from $2200.00 to $5700.00. Sole U.S. distributor, Kroll Trading Co., 133 Greene St., N.Y.C. OR 4-1414.

FOR SALE—Erie 300 ton, 40"x30" self-contained. HPM 200 ton downstroke. Baldwin 150 ton, 30"x20" self-contained. Watson Stillman 240 ton, ten 24"x56" platens. W & W 200 ton, 24"x42". Stokes Standard 50, 100 and 150 ton Semi-Automatics. D & B 150 ton, 25"x25". French Oil 120 ton self-contained. 120 ton Upstroke, 29"x21" 50 ton Birdsboro 24"x20". Stokes 15 ton automatics. Hydraulic pumps and accumulators. MPM 3½" wire covering Extruder. New ¾" plastic extruder. Other sizes to 6". Seco 6"x12" 2-Roll Mills and Calenders. Other sizes to 60". 60" Spreader Heads with XP motors. Despatch electric heated ovens and other types. New ¾ oz. Bench Model Model Injection Machines. Van Dorn 1 and 2 oz. Other sizes up to 100 oz. Baker-Perkins and Day Jacketed Mixers. Taylor-Stiles Pelletizer. 7½ HP. Plastic Grinders. Stokes & Colton Preform Machines. Partial listings. Send for bulletin #192. We buy your surplus machinery. Stein Equipment Company, 107-8th Street, Brooklyn 15, New York.

FOR SALE Plastic injection molding machine. Reed-Prentice, Model #10D-8. Serial #61909. Good condition, located in Detroit Area. Reply Box 6881, Modern Plastics.

Machinery Wanted

WANTED—Six to Eight Inch Extruder Wanted 20 to 1 ratio or longer. Must be in first class condition with variable speed motor. Screw, die, and heating system must be suitable for pelletizing polyethylene and polystyrene. Reply Box 6873, Modern Plastics.

WANTED to buy a three roll calender—length about 90". Reply Box 6887, Modern Plastics.

Materials Wanted

WANTED — PLASTICS OF ALL KINDS — virgin, reground lumps, sheet and reject parts. Highest prices paid for Styrene, Polyethylene, Acetate, Nylon, Vinyl, etc. We can also supply virgin and reground materials at tremendous savings. Address your inquiries to: Goldmark Plastic Compounds, Inc. 4-05 26 Ave. Long Island City 2, N. Y. RA 1-0880.

PLASTIC SCRAP WANTED — Acetate, acrylic, butyrate, polyethylene, styrene, vinyl, nylon, etc. We pay top dollar for your plastic scrap and surplus molding powders in any form. We also supply molding powders to the plastic industry at reasonable prices. Please contact for information: Philip Shuman & Sons, Inc., 571 Howard Street, Buffalo 6, New York—tel: TL 3-3111.

GET THE TOP MONEY FOR PLASTIC SCRAP—Now paying top prices for all thermoplastic scrap. Wanted: polystyrene cellulose, acetate, vinyl, polyethylene, butyrate, acrylic nylon. All types and forms including rejects and obsolete molding powders. Fast action wherever you are located. WRITE, WIRE, TODAY! Reply Box 6861, Modern Plastics.

WANTED — Plastic scrap. Polyethylene, Polystyrene, Acetate, Acrylic, Butyrate, Nylon, Vinyl. George Woloch, Inc., 514 West 24th Street, New York 11, N.Y.

(Continued on page 232)

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(Continued from page 230)

Materials For Sale

FOR SALE—2,236 lbs. Virgin Eastman Tentite Propionate Red Trsl. Product No. 307A-38741-H. In sealed fibre drums. At low rock bottom price. Reply, Purchasing Agent, Diamond Plastics Industries, P.O. Box 326, Roanoke, Va.

FOR SALE—1500 sheets Vinylite VS-5381 white 06 .045 gauge x 21¼ x 50½. Material prepared for piano key covering and is in perfect condition. Reply Box 6869, Modern Plastics.

FOR SALE—15000 lbs. jet black C/A pellets; 20000 lbs. virg. & repr. Natl. P/E; 5000 lbs. jet black E/C pellets; 10000 lbs. regr. grade A soft plastisol. Reply Box 6878, Modern Plastics.

Molds For Sale

FOR SALE—Plastic injection moulds for a toy helicopter for automatically changing hub. USA patent No. 2931132. The molds consist of 7 parts in new state. This toy helicopter is a fast selling item, it flies 50 to 60 feet high. Please write to Dux Toy Factory, Markes & Co. KG., Ludenscheid/Western Germany.

INJECTION MOLDS for sale, in good running condition that produce plastic toys and household items. For details call or write: Carle Tool Co. Ltd., 534 West First Avenue, Roselle, New Jersey —CH 5-9461.

Help Wanted

ENGINEERING MANAGER for Engineering Department of established New England custom molder. Must be heavy on managing people and administering tooling costs and progress. Knowledge and experience in thermoplastics, with strong emphasis on nylon molding techniques, mold design and product engineering required. Mechanical Engineer's degree preferred. Send complete data to Box No. 6874, Modern Plastics.

WANTED by one of the nation's foremost injection molding machinery manufacturers to sell complete line of Lombard machines. Territory northern Illinois. Should be familiar with trade. Must have thorough knowledge of thermoplastics and/or thermoplastic processing machinery. Proven sales record essential. All applicants must be of high caliber and able to furnish the best of references. Excellent compensation based on salary and commission. Job offers fine future and is open due to expansion of sales force. All replies will be held in confidence. Send resume to A. Nickerson, V.P., Lombard Governor Corporation, Ashland, Massachusetts.

MARKET RESEARCH & development (plastics) — Attractive opportunity for chemist or chemical engineer with sales or market research background. Must have thorough knowledge of the commercial plastics and be familiar with plastic forming techniques. Submit detailed background information and salary requirements to: W. Austin Bishop, Pennsalt Chemicals Corporation, 3 Penn Center, Philadelphia 2, Pennsylvania.

ENTERPRISING, versatile, young plastics engineer/chemist, preferably familiar with extrusion and compounding, to be trained as assistant manager for fast-growing plant in N. Y. metropolitan area. Must be adaptable to tackle a variety of problems in extrusion, compounding, laboratory testing, customer relations and general administration. Must be willing to put in long hours occasionally when needed. This job presents a challenge and considerable opportunity for right person. Please reply Box 6882, Modern Plastics.

PLASTICS ENGINEER required by Orenda. Canadian development laboratory requires a plastics or chemical engineer with at least three years experience in mold design and the compression molding of high quality reinforced phenolic and epoxy resin components. A knowledge of adhesive bonding is desirable. The position will involve the supervision of a laboratory presently engaged in the development molding of reinforced plastics and initiative and imagination will be required in suggesting and developing new applications for these materials. Enquiries should be addressed to the Personnel Manager, Orenda Engines Limited, P. O. Box 4015, Terminal A, Toronto, Ontario, Canada.

PACKAGING DEVELOPMENT CHEMIST —B.S. or M.S. Chemist or Engineer with at least 3 years experience in flexible packaging. Familiarity with properties of plastic films, laminates and coatings and with end-use requirements for specific applications in the food industry would be desirable. Position offers challenging work, good salary, benefits and growth potential. Pleasant suburban location in North Central N.J. 45 minutes from N.Y.C. Mail complete resume with salary requirements to Personnel Manager. Air Reduction Co., Inc., Central Research Laboratories, Murray Hill, New Jersey.

PLASTICS — Shop superintendent. Experienced plastics Engineer as shop superintendent of Closure Department for injection molder located in Long Island City. Supervisory operating and tooling experience required. Engineering degree preferred. Salary commensurate with experience. Reply Box 6868, Modern Plastics.

MANUFACTURERS REPRESENTATIVE —Wanted for sales of Thermoforming, Expandable Styrene, Die Cutting and Blister Packaging Equipment. Opening for experienced men. Send complete information to Box No. 6870, Modern Plastics.

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ADVANCEMENT POTENTIAL — Excellent opportunity for Chemist or Chemical Engineer with plastics experience who has the potential to advance rapidly to the administrative level in a Process Control and Development Laboratory. Location within 200 mile radius of Chicago. Write, giving full details of education, experience, and salary desired to Box 6879, Modern Plastics.

WANTED—EXPERIENCED EXECUTIVE in plastic shapes and profile extrusions. Multi-plant national corporation seeks executive with over 8 years experience for management position in production and sales of plastic shapes and profile extrusions. New York City location. Age no factor. Liberal financial arrangement. All replies held in strict confidence. Send resume and salary requirement to Box 6859, Modern Plastics.

ENGINEER — Immediate opening for young, ambitious electro-mechanical engineer for plant process development in organization with outstanding growth history in flexible plastic packaging. EE or ME degree with up to 10 years experience. Future limited only by ability. Located near Greenville, South Carolina. New air-conditioned plant in foothills of Great Smoky Mountains with its attendant excellent recreational features. Send resume including salary requirements to: Mr. R. A. Mattson, W. R. Grace & Co., Cryovac Division, P. O. Box 233, Simpsonville, S.C.

SALES REPRESENTATIVE WANTED — For Southwest manufacturer of vinyl extrusions. Prefer man with considerable background and experience in sale of spline and weatherstrip to the window and screen industry. Compensation arrangements open. Send complete resume, recent photograph, and compensation expected. Navaco Company, 601 Hall St., Dallas 26, Texas.

FILM TECHNOLOGISTS — Our Central Research Division is seeking an engineer experienced in film fabrication from polymeric materials. A minimum of a B. S. degree and several years industrial experience concerned with casting, blowing and extrusion techniques and equipment are desired. Eventual project supervision is anticipated. The Stamford Laboratories are located in southwestern Connecticut, about 35 miles from New York City, with easy access to many other research and higher educational organizations. Reply to: Mr. D. E. Rowland, AMERICAN CYANAMID COMPANY, Stamford, Connecticut.

MECHANICAL ENGINEER—Unusual opportunity for an aggressive engineer to participate in an accelerated expansion program. Position requires an ME degree plus 3 to 5 years plant experience. However, we will consider applicants without a degree provided they have experience in the design and development of equipment and machinery in one or more of the following areas: web coating, drying, slitting, packaging and handling. This is an excellent growth opportunity which offers good salary and liberal benefits. The job location is Stamford, Connecticut. Forward complete resume including previous earnings to Box 6863, Modern Plastics.

SALES REPRESENTATION open in Texas and Ohio. We are leading suppliers of metallized plastic sheeting in all sorts of industrial laminated combinations. The men we seek to represent us must be top calibre salesmen accustomed to high earnings. If you are looking for a chance to make big money, here it is. Tell us about yourself in detail. Box 6884, Modern Plastics.

PLASTIC INJECTION Machine Designers. Must have a minimum of five years experience in the design of Plastic Injection machinery. Knowledge of Hydraulics very desirable. The salaries for these positions are open. The usual fringe benefits are offered such as pensions, sick leave, vacations, insurance, etc. Send resume to—The National Automatic Tool Co., Inc., So. 7th and "N" Streets, Richmond, Indiana.

MANUFACTURER'S REPRESENTATIVE wanted by growing and progressive custom molder in St. Louis. Desire men with some plastic experience. All territories open. Reply Box 6885, Modern Plastics.

EXTRUSION EXPERT—Expd. profile extrusion, tubing, all thermoplastics; excellent opportunity. Leading NYC firm. Box MP 595, 125 W 41 St., NYC.

PROCESS ENGINEER — Major manufacturer and fabricator of laminated plastics has an outstanding career opportunity for Chemical Engineer to assume diversified Process Engineering Assignments. Applicant must have a broad background in treating and pressing operations and a good knowledge of resins, papers, and cloths used for high pressure laminates. Work will include process improvements, new techniques, and cost reduction activities. Send complete details of experience, background and salary required to: Reply Box 6880, Modern Plastics.

FIELD ENGINEER — PLASTIC EXTRUSION—Attractive opening for a man with plastic extrusion experience to service extrusion accounts. If you have a flair for meeting people and helping to solve their technical problems and enjoy traveling, submit your resume today. An Engineering Degree is helpful but you can qualify based on experience in plastic extrusion production. Write in confidence to: N. H. Petersen, Placement Manager, Marbon Chemical Div., Borg-Warner Corp., P.O. Box 68, Washington, W. Va.

HELP WANTED — SALESMAN — With some experience in plastic packaging, preferably in container field. Metropolitan New York territory. Must have car. Will give drawing. Reply, stating age, experience, etc. P. O. Box 150, Times Plaza Station, Brooklyn 17, New York.

(Continued on page 234)

How reinforced plastics molders and high pressure laminators save time, work, material, money with **Phenopregs***

1. Phenopreg prepregs simplify molding operations. Only one material—containing both resin and reinforcement—is used. This eliminates the need for weighing, mixing and hand-applying the compounds. Also the need for resin-reinforcement ratio control.

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4. Phenopregs mean cleaner molding operations. They eliminate the need for cleaning up after wet molding, saving time, labor.

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7. Phenopregs produce better products. Phenopregs are superior because they enable the molder to (a) keep a uniform resin-reinforcement ratio throughout his laminate; (b) exercise strict control over the resin content; (c) control the cure because of the even dispersion of curing agents; (d) avoid defect-producing trapped air pockets or tiny air bubbles; and (e) eliminate the harmful effects of moisture . . . since the Phenopregs come predried.

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Situations Wanted

REINFORCED PLASTICS PANEL SPECIALIST—Experience includes: research, equipment design, plant start-up, and market development. Seeking assignment with particular emphasis on efficiency, quality and problem areas. Please write Box 6865, Modern Plastics.

PLASTICS ENGINEER, Overseas Chinese, with M.E. degree, trained in U.S.A. and West Germany, well experienced in maintenance and new molding process, seeks suitable position in any country. Address: P.O. Box 1423, Hongkong.

SALES EXECUTIVE establishing residence in Japan. Strong background in managing overseas operations for manufacturers of heavy equipment for the plastics, rubber and petrochemicals industries. Familiar with important licensing and customs proceedings. Seeks responsible position with reputable far-east firm. Unlimited initiative. Reply box 6876, Modern Plastics.

POSITION WANTED—ADVERTISING—MARKETING MANAGEMENT. Over 10 years with top plastics company. Five years in public relations and advertising with chemical division making vinyl resin, plasticizers, man-made rubber, and 5 years as Advertising & Sales Promotion Manager for plastics division for vinyl coated fabrics, film, rigids. Best known brand in the business. Know architectural, building, furniture, luggage, interior design, rainwear, shower curtains, many other consumer and industrial markets. Winner of 4 national advertising awards. Age 34, married, B.S.J. Will relocate. Write for resume. Box 6886, Modern Plastics.

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PLASTICS, RUBBER AND PAPER CONVERTING EQUIPMENT—Mech. Engineer, German immigrant, skilled designer, author of several technical publications, hard and efficient worker, offers bonanza to enterprising American firm: Am ready to develop and to put to work a broad range of diversified modern equipment for extrusion, injection molding (screw or plunger pre-plasticizing type), blow molding (extrusion and injection method), vacuum forming, laminating, coating (extrusion and others), embossing, calendering. Molds of any kind. Excellent contacts to European Common Market area for licensing and/or selling purposes. Box 6871, Modern Plastics.

Business Opportunities

PLASTIC EXTRUSION business wanted. Prefer Midwest or Southern location. Replies held in strictest confidence. Write full details to Modern Plastics, Box No. 6872.

FOR SALE — Slitting and Sheeting Business for Plastic Films and Other Materials; two machines; list of good customers; lease; good reputation in trade for over 30 years; small down payment; terms arranged; good opportunity to build up business. Reply Box 6883, Modern Plastics.

BELGIAN COMPANY—Young and enterprising, with injection and extrusion plant, interested in contacting American firm for purposes of expansion and development. Reply Box 6862, Modern Plastics.

MARKETING AND SALES MANAGER—Age 35, Harvard B.S., Columbia M.A., 12 years successful marketing experience. New product development, sales, and advertising programs for nationally distributed products. Specialize product diversification, market expansion. Effective coordination of sales and production. Developed and sold products opening million dollar markets. Both creative and practical. Maintain excellent relations with associates and customers. Box 6888, Modern Plastics.

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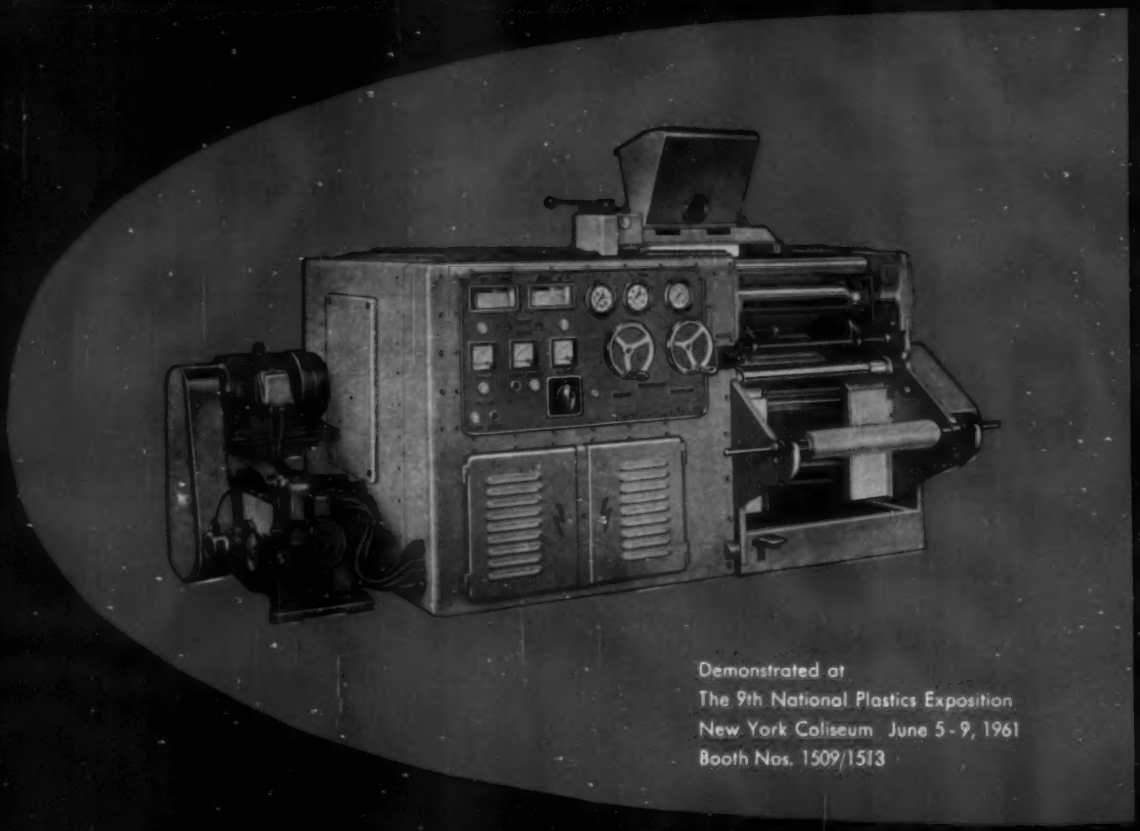

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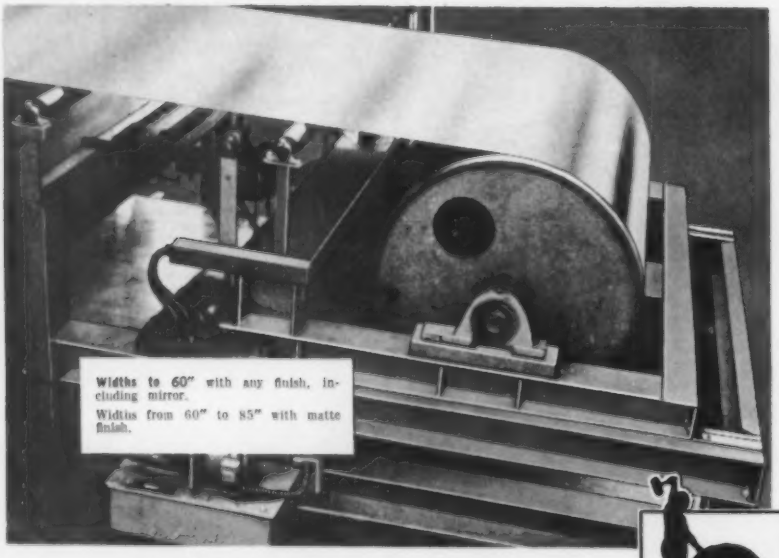

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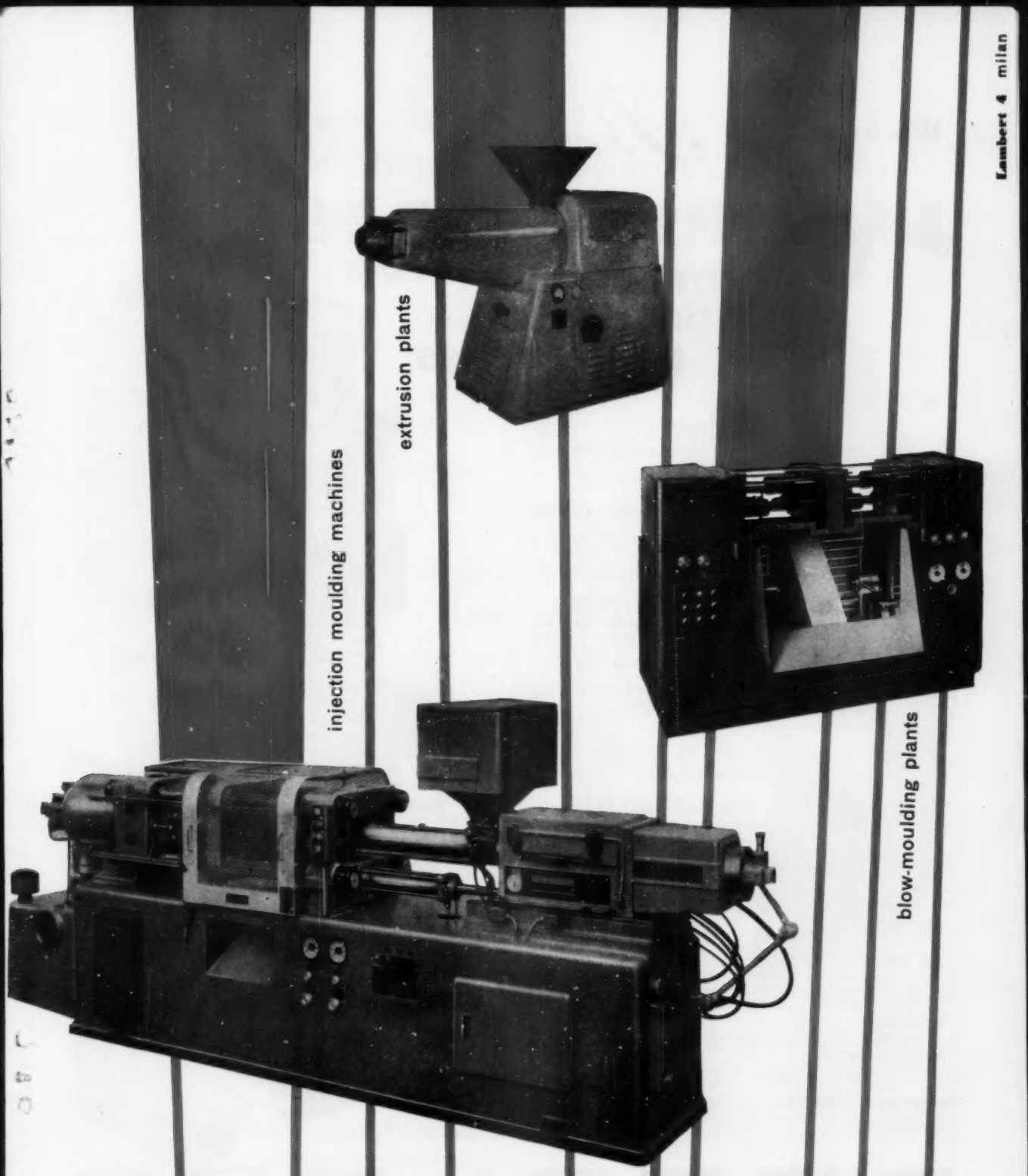

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NEGRI BOSSI & C.

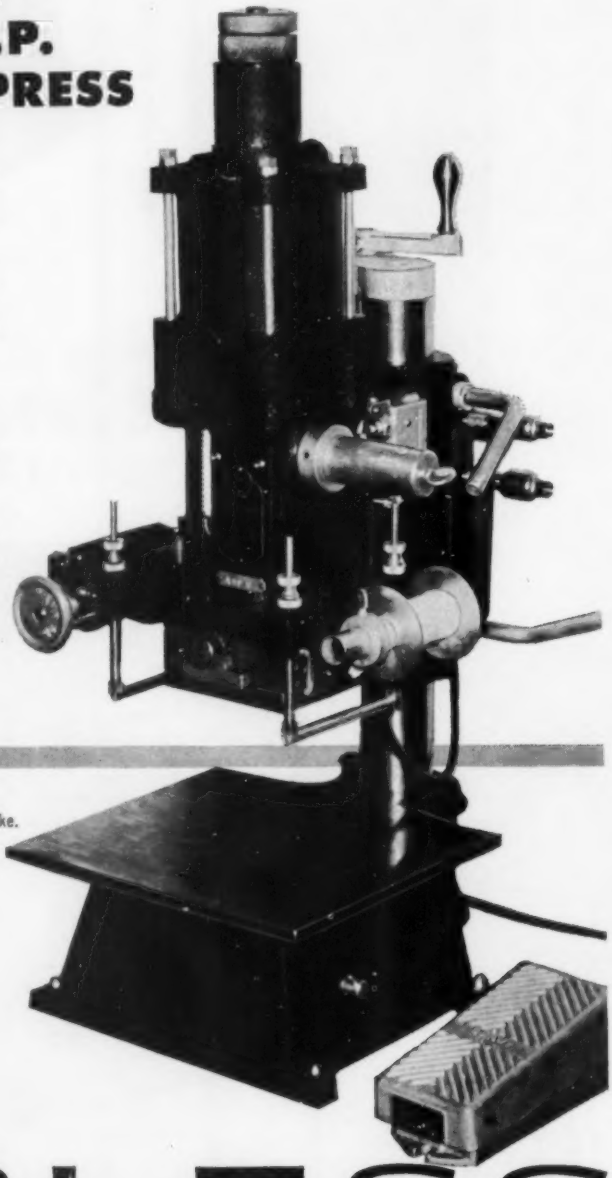
PLASTIC MACHINERY

MILANO - Via Bazzini, 24 (Italy) Tel. 235.555 - 230.512 - 235.884 Teleg.: NEGRIBOS - MILANO

the new *Peerless*

STAMPING PRESS

AIR-OPERATED MODEL A.B.P. BENCH PRESS



★ **FAST OPERATOR**

for hot stamping on cloth, paper, leather, wood, fibre, soft and hard plastics, hard rubber and most other materials. PEERLESS ROLL LEAF available in gold, imitation gold, aluminum, a wide range of pigment and metallic colors.

★ **AIR OPERATED**

Press has a built in air cylinder which is cushioned at both ends of cylinder to avoid hammer blows on work.
In addition to raising and lowering screw we have included a micrometer adjustment at top of cylinder for adjustment of impression.
Press is equipped with a timing relay for dwell control.

★ **FOOT OR HAND CONTROL**

Foot control, standard equipment, leaves operator's hands free to position articles to be stamped. Also available with hand control. Speed adjustment permits up to 40 impressions a minute, depending on articles and materials being stamped.

★ **AUTOMATIC HEAT CONTROL**

Electrical outlet built into press. Pilot light, thermometer, insure uniform temperature.

★ **AUTOMATIC ROLL FEED**

Adjustable, feeds up to 5" of leaf 4¼" wide. Side to side feed.

★ **BUILT FOR PUNISHMENT**

by Peerless, pioneers in roll leaf stamping.

SPECIFICATIONS

SIZE:
15" wide x 19" deep x 36" high. Depth of throat opening 6" from center of heat. 5" maximum opening from die plate to table. 2" stroke.

STATIONARY TABLE:
12" x 11"

AIR PRESSURE:
Not less than 2 h.p. compressor — 80 lb. pressure equipped with 60 gallon tank. Compressor not supplied.
Pressure approximately 19 times line pressure.

ELECTRICAL:
110 volts A.C., unless otherwise specified.

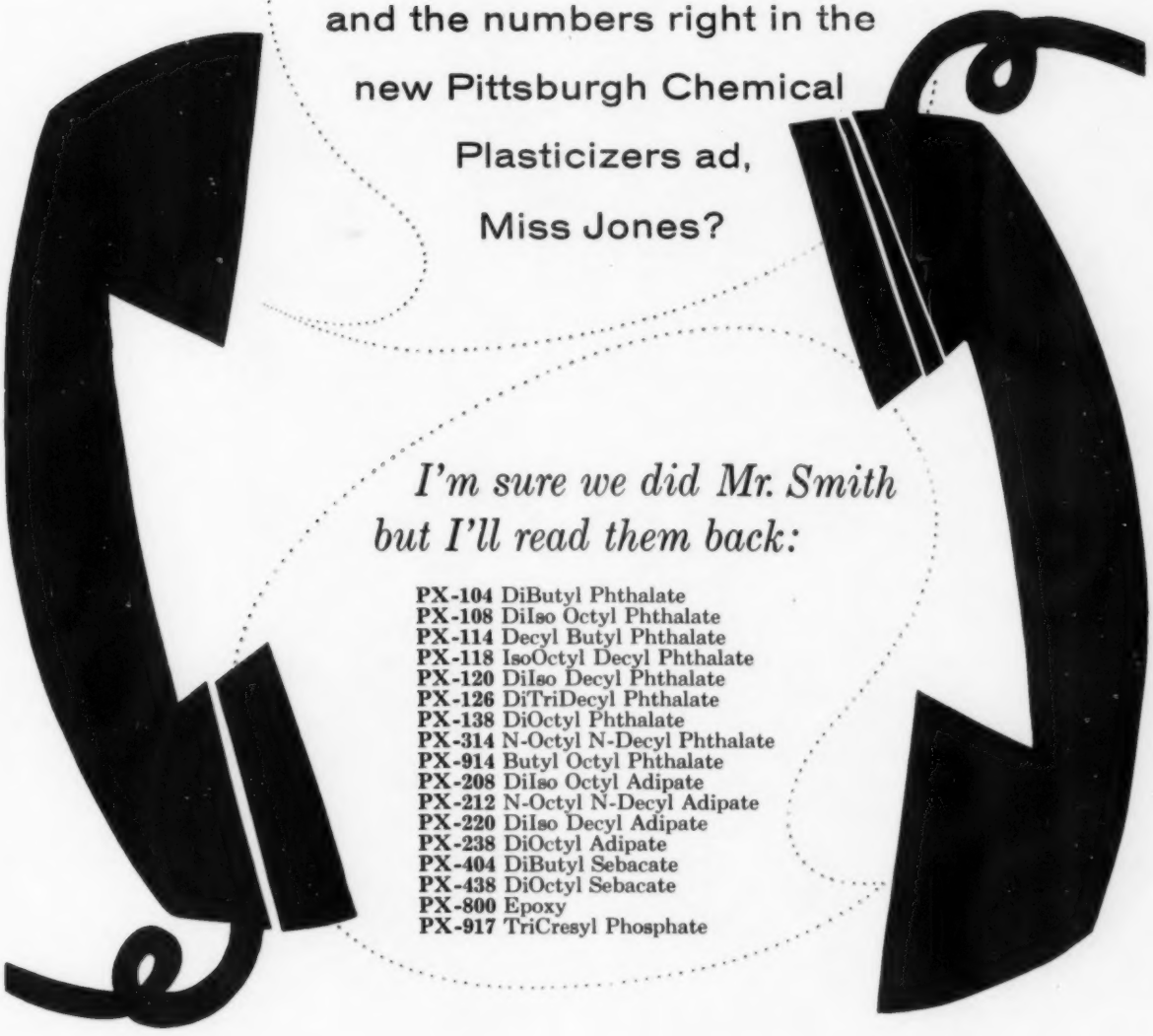
SHIPPING WEIGHT:
220 lbs. Net, 270 lbs. Gross
Head size: 4" x 5"
Die plate size: 4" x 5"
Chase size, inside: 3" x 4"

EQUIPMENT INCLUDES:
lubricator, regulator, strainer and 6 ft. of hose.

PEERLESS

ROLL LEAF CO.
division of **HOWE SOUND** *company*
4511-4515 New York Avenue • Union City, N. J.
BRANCH OFFICE: BOSTON · DISTRIBUTORS: CHICAGO · ST. LOUIS

Did we get the names and the numbers right in the new Pittsburgh Chemical Plasticizers ad, Miss Jones?



I'm sure we did Mr. Smith but I'll read them back:

PX-104 DiButyl Phthalate
PX-108 DiIso Octyl Phthalate
PX-114 Decyl Butyl Phthalate
PX-118 IsoOctyl Decyl Phthalate
PX-120 DiIso Decyl Phthalate
PX-126 DiTriDecyl Phthalate
PX-138 DiOctyl Phthalate
PX-314 N-Octyl N-Decyl Phthalate
PX-914 Butyl Octyl Phthalate
PX-208 DiIso Octyl Adipate
PX-212 N-Octyl N-Decyl Adipate
PX-220 DiIso Decyl Adipate
PX-238 DiOctyl Adipate
PX-404 DiButyl Sebacate
PX-438 DiOctyl Sebacate
PX-800 Epoxy
PX-917 TriCresyl Phosphate

You can hardly miss the point that Pittsburgh Chemical makes a lot of plasticizers. We don't particularly *like* making so many kinds, but we've discovered that our customers have a very great variety of compounding and end-product requirements. And they're *glad* they can fill most or *all* of their needs at Pittsburgh Chemical. If *you* buy plasticizers, give us a call. Chances are, we'll be able to help you produce an even better product . . . at lower cost. Contact your nearest Pittsburgh Chemical office and learn how Pittsburgh "Job-Rated" Plasticizers can do the job for you!

2753

INDUSTRIAL CHEMICALS DIVISION

PITTSBURGH CHEMICAL CO.

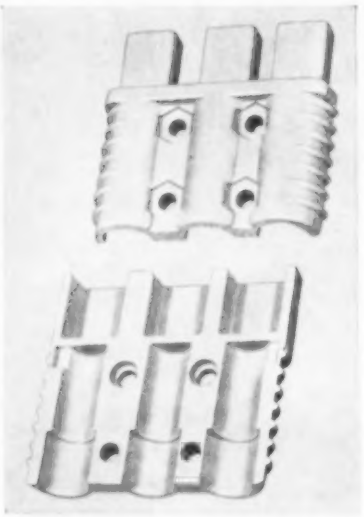
GRANT BUILDING PITTSBURGH 19, PA.

A Subsidiary of PITTSBURGH COKE & CHEMICAL CO.

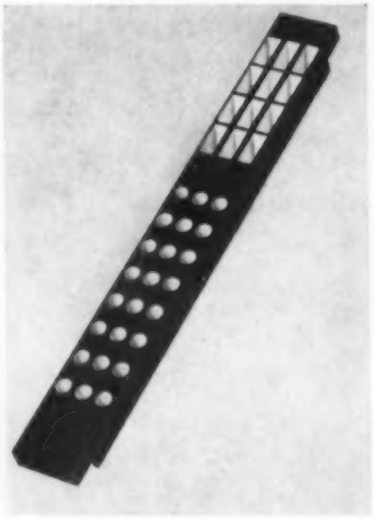
CALL YOUR NEAREST PITTSBURGH CHEMICAL SALES OFFICE . . . PITTSBURGH, NEW YORK OR CHICAGO

G-E LEXAN® POLYCARBONATE RESIN

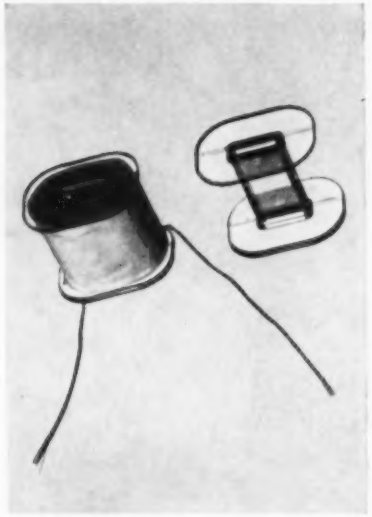
TOUGHEST OF PLASTICS!



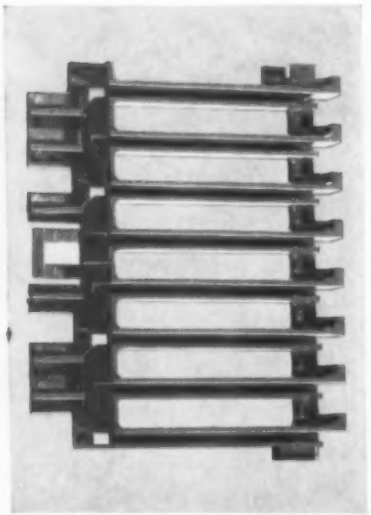
STRENGTH LEXAN resin has an impact strength of more than 12 foot-pounds per inch of notch — higher than any other plastic! This toughness, plus heat resistance and good electrical properties, make LEXAN resin an outstanding choice for 3-pole connectors used in rugged service on electric trucks.



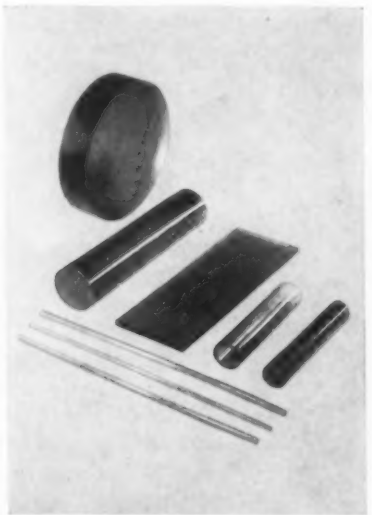
HEAT STABILITY Lampholder terminal block is used inside electronic equipment where heat is difficult to dissipate. LEXAN polycarbonate resin replaced another thermoplastic which melted under severe thermal conditions. LEXAN has a heat distortion point as high as 290°F. Also keeps high strength in sub-zero cold.



ELECTRICAL PROPERTIES A good dielectric, LEXAN resin is non-corrosive even when used with very fine Class F magnet wire. Coil forms must not distort at temperatures above 200°F under stresses caused by tightly wound wire. LEXAN resin provides high heat distortion temperatures under load.



DIMENSIONAL STABILITY Card Guide for business machines is molded to close tolerances . . . must undergo minimum change in dimensions during service. Parts show excellent dimensional stability under moist and high temperature conditions. LEXAN resin meets self-extinguishing requirement.



TRANSPARENCY Stock shapes and film of LEXAN polycarbonate resin have excellent transparency. Bar stock is easily machined; film can be thermoformed, heat-sealed and solvent-sealed. Combination of clarity, toughness and malleability gives LEXAN resin the design capabilities of a transparent metal!

LEXAN OPENS UP NEW OPPORTUNITIES...
Even before LEXAN entered large-scale production, manufacturers, impressed by its exceptional properties, developed and field tested over 300 applications. G.E. participated in these developments. With the opening of new G-E facilities capable of producing millions of pounds of LEXAN per year, the price of this versatile thermoplastic has dropped dramatically – over 40% in a single year. This fact alone has brought many new products within the range of feasibility. Can you afford to overlook the opportunities presented by LEXAN? Send for details on price, properties, applications and G-E's technical assistance program today! General Electric, Chemical Materials Department, Section MP-41, Pittsfield, Mass.

LEXAN®
Polycarbonate Resin

GENERAL ELECTRIC